

N63 22171

Code-1

NASA CR-50971

OTS PRICE

XEROX \$ _____

MICROFILM \$ _____

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

207
2463

; JPL WT 21-128) O75:8

TEST OF THE NAA X-15 MODEL IN THE
JPL 21-INCH HYPERSONIC
WIND TUNNEL

Robert W. Weaver

3 refs

Robert E. Covey
Robert E. Covey, Chief
Aerodynamic Facilities Section

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA
April 18, 1963

CONTENTS

I. Introduction	1
II. Model Description	1
III. Wind Tunnel and Instrumentation	1
IV. Test Procedure	2
V. Data Reduction	2
VI. Results	3
Nomenclature	4
References	5
Tables	6
Figures	
Plots	

TABLES

1. Average aerodynamic parameters	6
2. Coefficient repeatability	6

FIGURES

1. X-15 model with control surfaces deflected	
2. Sign conventions	

PLOTS

Plot No.	Run No.	Configuration	δ_{H_R} (deg)	δ_{H_L} (deg)	β (deg)	Mach No.
1	5	B ₆ W ₂ X ₁₄ H ₉ V _{u5} V _{L7}	-35	-35	0	5
1	6	B ₆ W ₂ X ₁₄ H ₉ V _{u5} V _{L7}			-5	
2	7	B ₆ W ₂ X ₁₄ H ₉ V _{u5} V _{L7} T ₃			0	
↓	8				-5	
	9				+5	
3	10		0	0	0	
↓	11				-5	
	12				+5	
4	13		-20	-20	0	
↓	14				-5	
	15				+5	
5	16		-35	-35	0	6
↓	17				-5	
	18				+5	
6	19		0	0	0	
↓	20				-5	
	21				+5	
7	22		-20	-20	0	
↓	23				-5	
	24				+5	

PLOTS (Cont'd)

Plot No.	Run No.	Configuration	δ_{HR} (deg)	δ_{HL} (deg)	β (deg)	Mach No.
8	25	B ₆ W ₂ X ₁₄ H ₉ V _{u5} V _{L7}	-35	-35	0	6
8	26		-35	-35	-5	
9	27		0	0	0	
9	28				-5	
10	29	B ₆ W ₂ X ₁₄ H ₁₉ V _{u5} V _{L7}			0	
	30				-5	
	31				+5	

I. INTRODUCTION

Wind-tunnel Test 21-128 was a test of the North American Aviation, Inc. (NAA), Los Angeles Division, 0.02-scale X-15 model. The purpose of the test was to obtain longitudinal and lateral stability and control data for the complete model. The approximate aerodynamic parameters for the test were Mach No. 5.0 and 6.0 and corresponding Reynolds No./in. of 0.28×10^6 and 0.25×10^6 . The test variables-and-ranges were angle of attack from 0 to 28 deg, and angle of yaw from -5 to +5 deg. The model configuration consisted of the basic X-15 model with wing-tip modifications. Forces and moments were obtained for the complete configuration.

The test* was conducted at the Jet Propulsion Laboratory (JPL) during the period from October 22 through October 25, 1962, with NAA represented by Mr. J. R. Ongarato.

II. MODEL DESCRIPTION

The model is shown in Fig. 1. A more detailed description of the model and components is contained in Ref. 1.

III. WIND TUNNEL AND INSTRUMENTATION

Reference 2 describes the construction and operating conditions of the 21-in. hypersonic wind tunnel. The wind tunnel has a nominal test-section size of 21 in. square, a Mach range from 5 to 10, a flexible-plate nozzle, and

*Symbols used in this Report are defined in the Nomenclature.

operates with continuous flow. Table 1 presents representative values of the test-section flow parameters for the Mach numbers at which this test was conducted.

A six-component, internal, strain-gage balance was used to measure force-and-moment data.

IV. TEST PROCEDURE

Prior to actual test operations, measurements were made to determine the position of the model, the deflection constants, and the balance tares. During the test, data points were obtained at successive values of angle of attack. These data points were plotted vs. angle of attack, and any data which appeared questionable were checked before the conclusion of the run. At least one data point was checked even if all data appeared correct.

V. DATA REDUCTION

The force-and-moment data were reduced to dimensionless coefficients in coordinates specified by NAA. The coefficients were obtained as follows:

$$\text{force coefficient} = \frac{\text{force}}{qA}$$

$$\text{moment coefficient} = \frac{\text{moment}}{qAd}$$

where

q = free-stream dynamic pressure (psi)

A = reference area = 11.520 (in.²)

d_m = reference length = 2.465 (in.)

d_y = d_R = reference length = 5.366 (in.)

and the point about which the moments were measured was 6.80 in. from the model base, on the model centerline.

The coefficients were obtained on a digital computer by a standardized series of formulae as indicated in Ref. 3. The repeatability of the coefficient data is indicated in Table 2.

The coefficients are defined in the Nomenclature, and the coefficient sign conventions are shown in Fig. 2.

VI. RESULTS

The results of this test have been reduced to dimensionless coefficients and are presented in Plot Series 1a through 10c*. No attempt was made in this Report to interpret the results.

*Also numbered from Plots 1 through 30 in the lower left-hand corner of the ozalid plot pages.

NOMENCLATURE

Symbol

A	model reference area (11.52 in. ²)
d_m	pitching moment reference length (2.465 in.)
d_R	rolling moment reference length (5.366 in.)
d_y	yawing moment reference length (5.366 in.)
C_D	chord force aerodynamic coefficient in the stability axes system (shown as CD on the plots)
C_M	pitching moment aerodynamic coefficient in the stability axes system (shown as CM on the plots)
C_L	normal force aerodynamic coefficient in the stability axes system (shown as CL on the plots)
α	angle of attack in the body axes system (positive nose up)
β	yaw angle (positive nose left)
δH_L	left horizontal control surface deflection angle (positive leading edge up)
δH_R	right horizontal control surface deflection angle (positive leading edge up)

Axes Systems

Body axes	an orthogonal axes system with the origin at the model center of gravity and fixed with respect to the model
Stability axes	an orthogonal axes system with the origin at the model center of gravity and which rotates with the model in yaw and roll

REFERENCES

1. North American Aviation, Inc. Test and Model Information for Wind-Tunnel Tests of a 0.02-Scale Model of the X-15 Research Vehicle in the JPL 21-Inch Hypersonic Wind Tunnel, Wind-Tunnel Projects Staff. Los Angeles, California, NAA, August 6, 1962 (Rev. October 10, 1962). (Report No. NA-62-862) UNCLASSIFIED.
2. Jet Propulsion Laboratory, California Institute of Technology. Wind-Tunnel Facilities at the Jet Propulsion Laboratory, Wind-Tunnel Staff. Pasadena, California, JPL, April 18, 1961 (Rev. January 1, 1962). (Technical Release No. 34-257) UNCLASSIFIED.
3. Jet Propulsion Laboratory, California Institute of Technology. Equations for Wind-Tunnel-Force Data Reduction, Wind-Tunnel Staff. Pasadena, California, JPL, April 19, 1957. (Internal Memorandum SWT G-T3) UNCLASSIFIED.

Table 1. Average aerodynamic parameters

Parameter	Mach Number	
	5	6
Static pressure (psia)	0.155	0.098
Stagnation pressure (psia)	81.9	154.1
Dynamic pressure (psia)	2.71	2.46
Reynolds number (per in. $\times 10^{-6}$)	0.28	0.23

Table 2. Coefficient repeatability

Mach No.	Coefficient*		
	C_L	C_M	C_D
5	0.0020	0.0020	0.0013
6	0.0015	0.0019	0.0023

*Based upon the following reference area and lengths: $A = 11.520$ (in. 2);
 $d_m = 2.465$ (in.), $d_R = d_y = 5.366$ (in.)

JPL WT 21-128

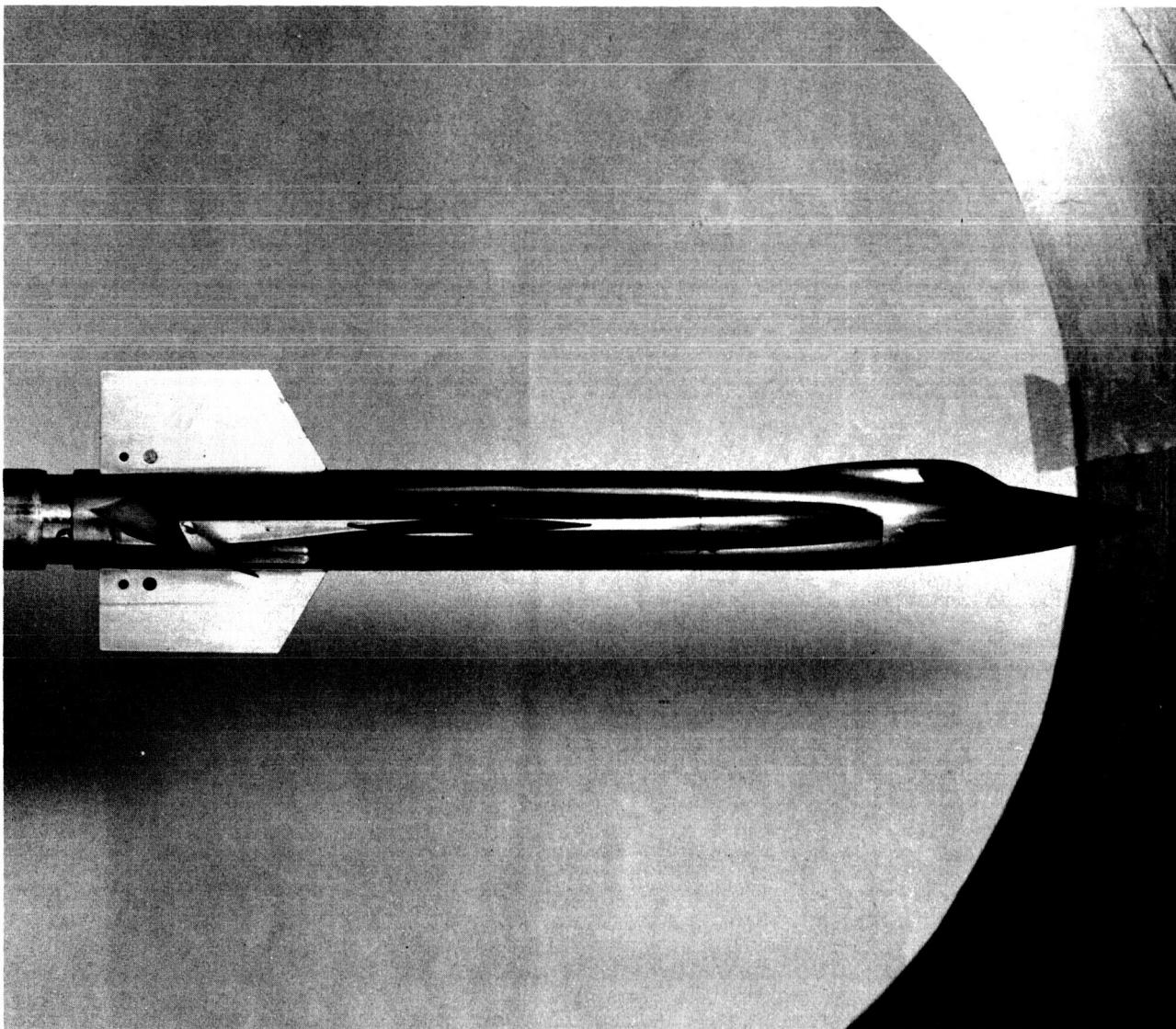


Fig. 1. X-15 model with control surfaces deflected

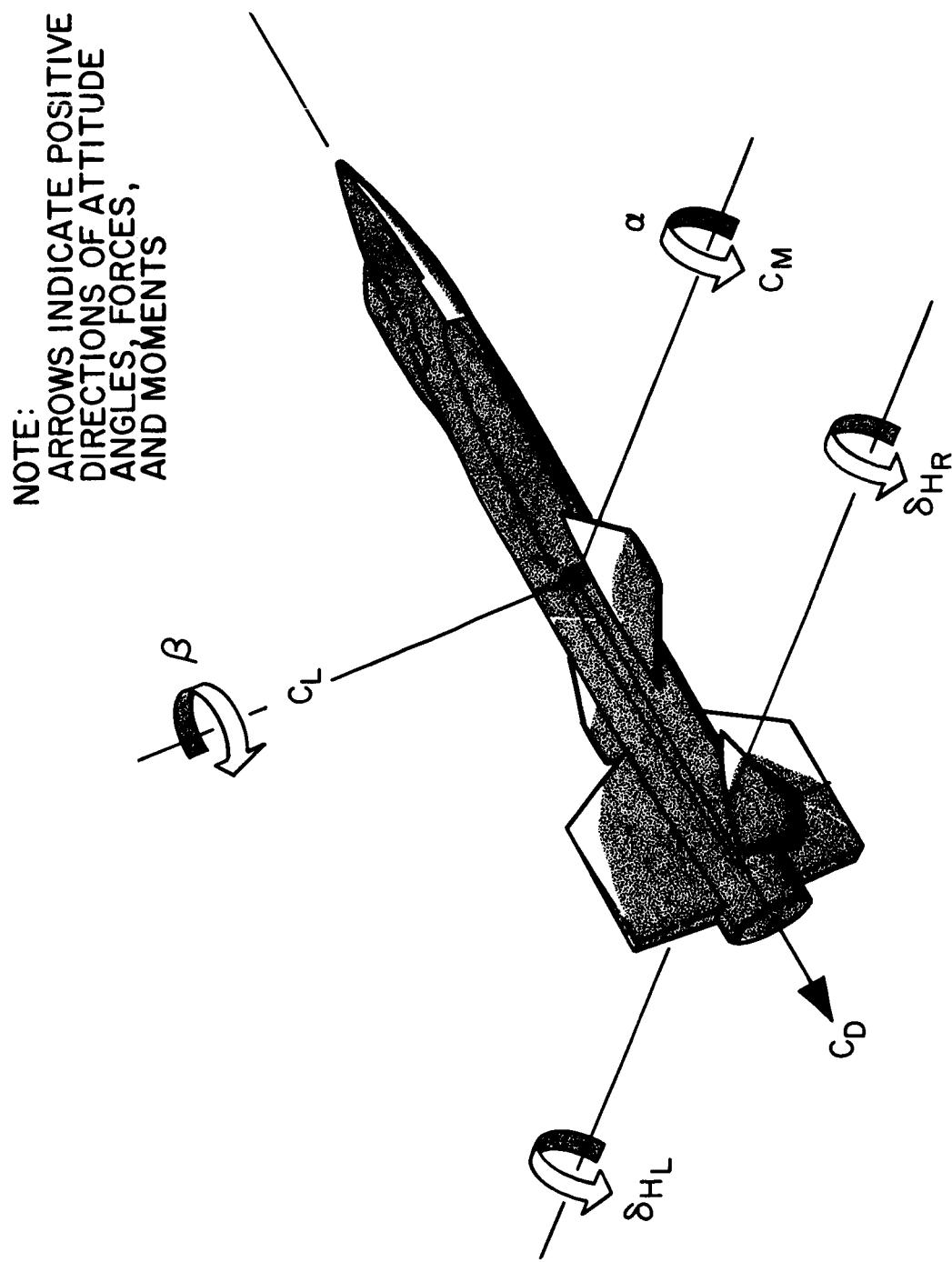
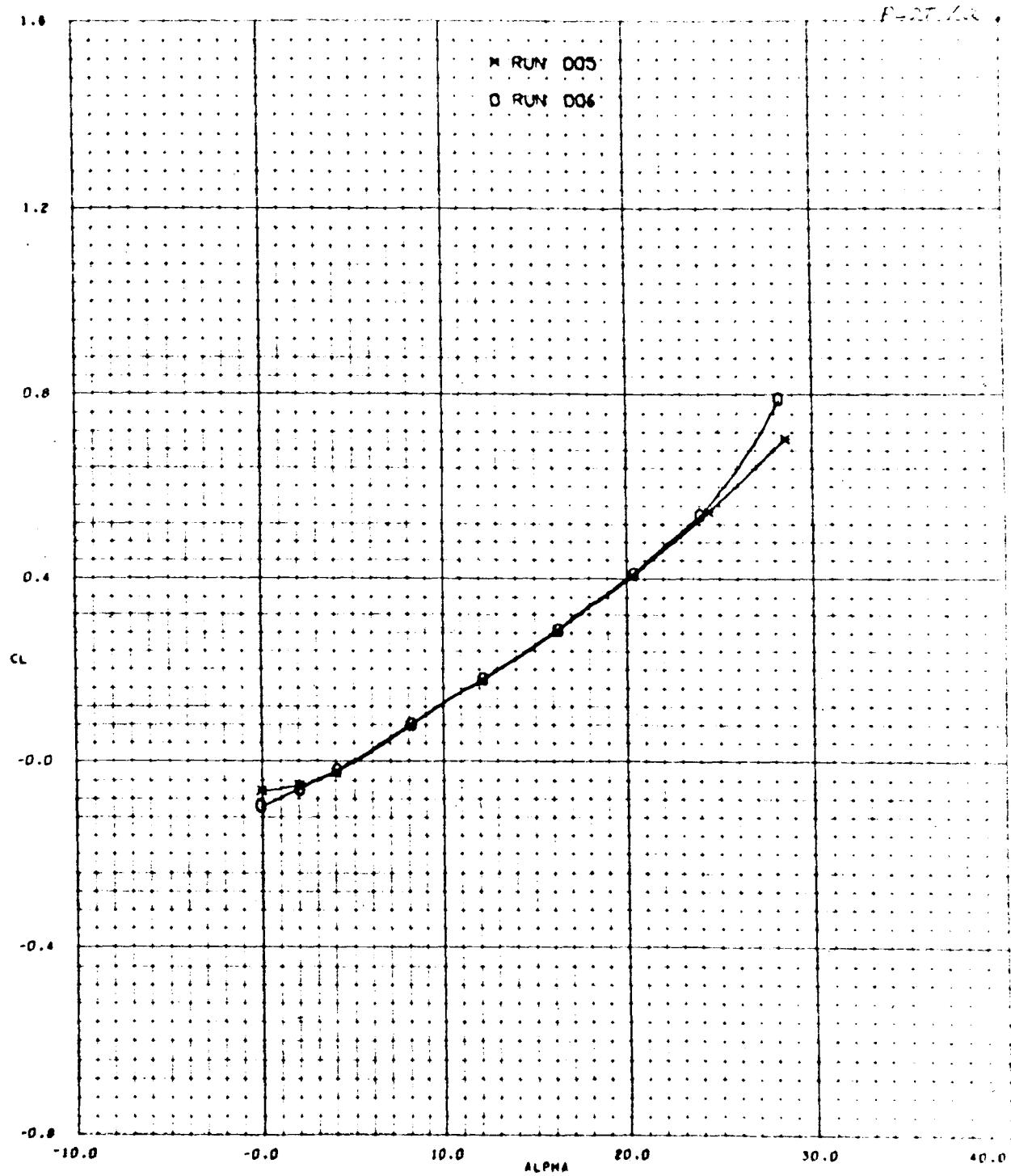
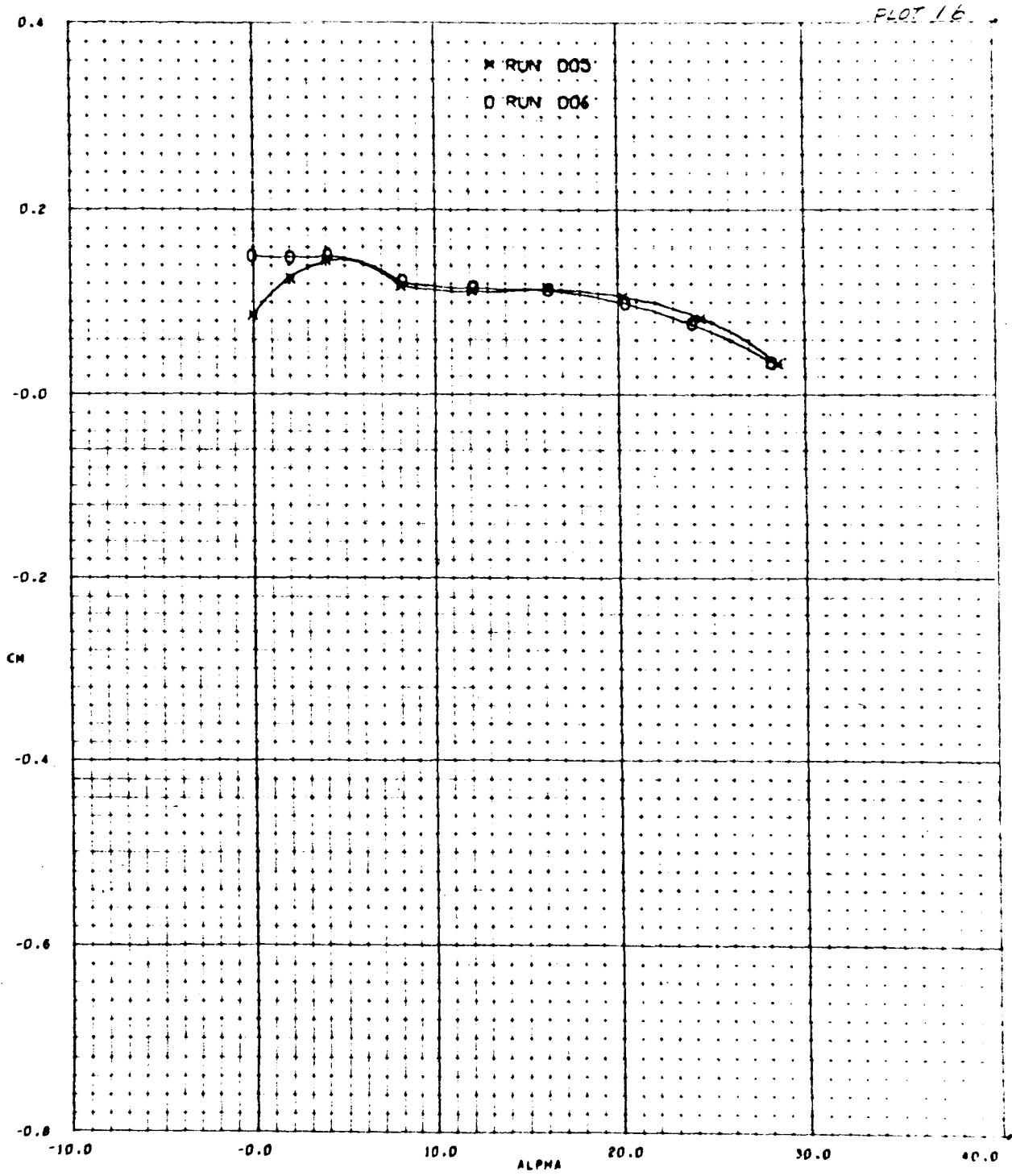
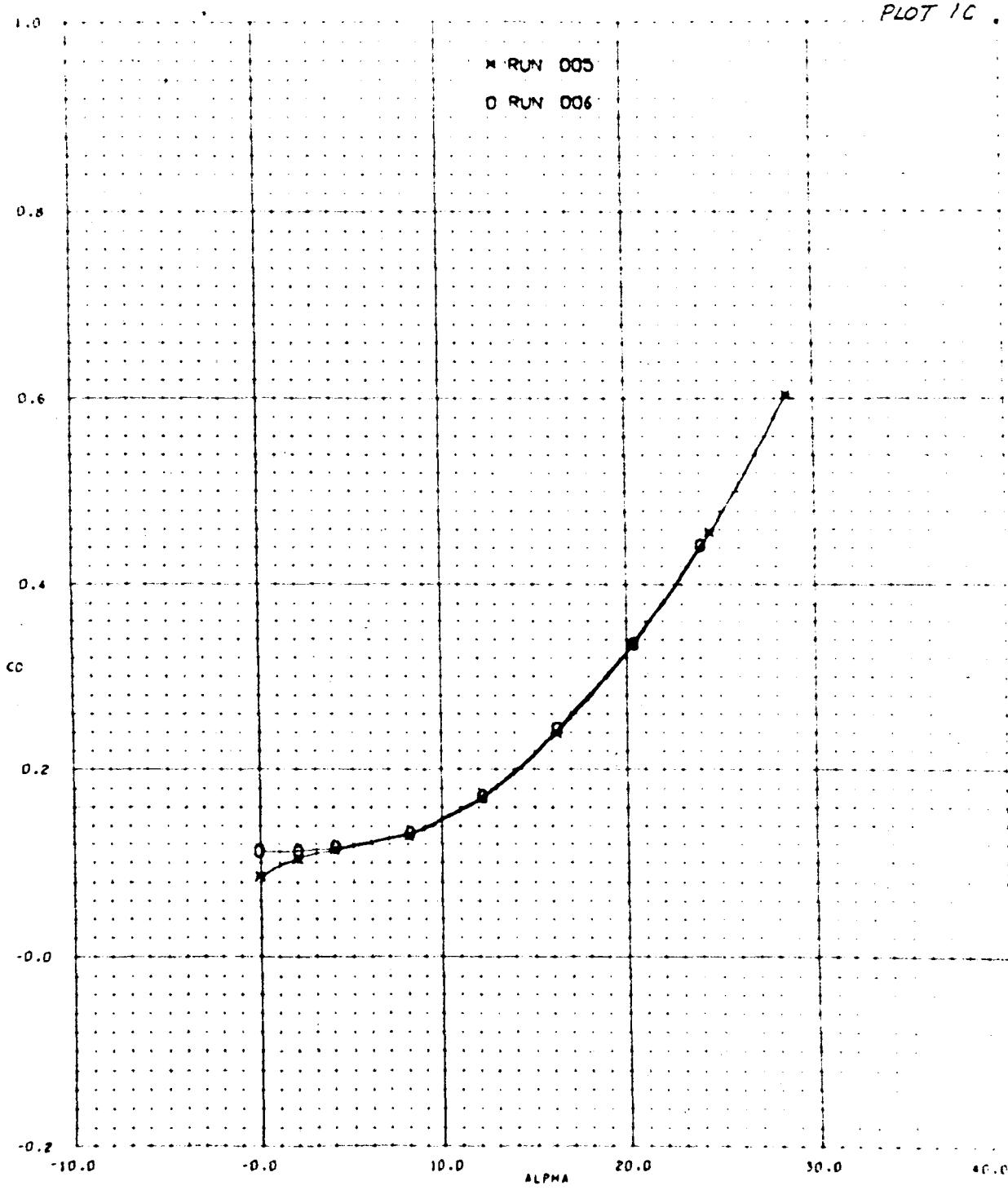
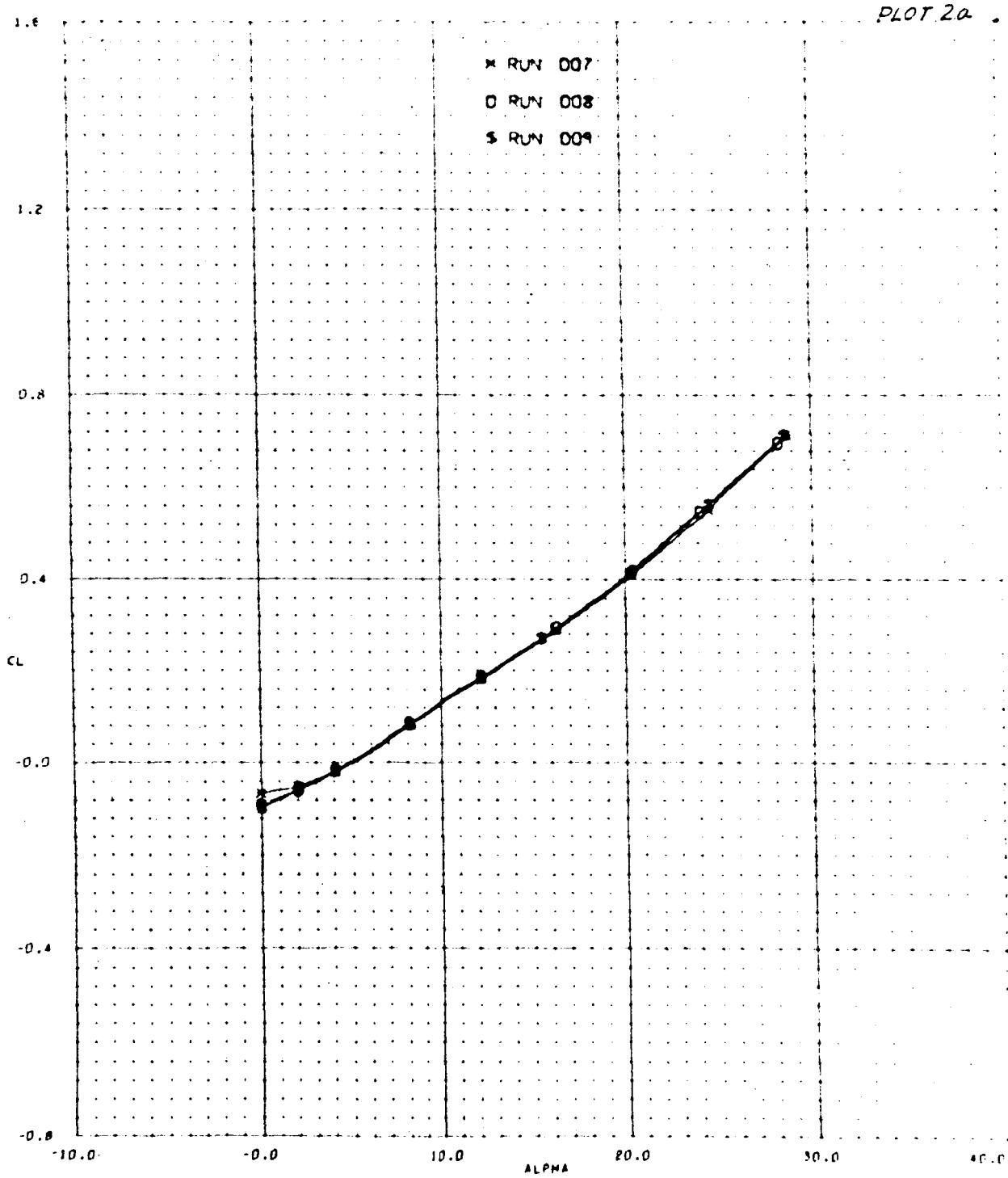


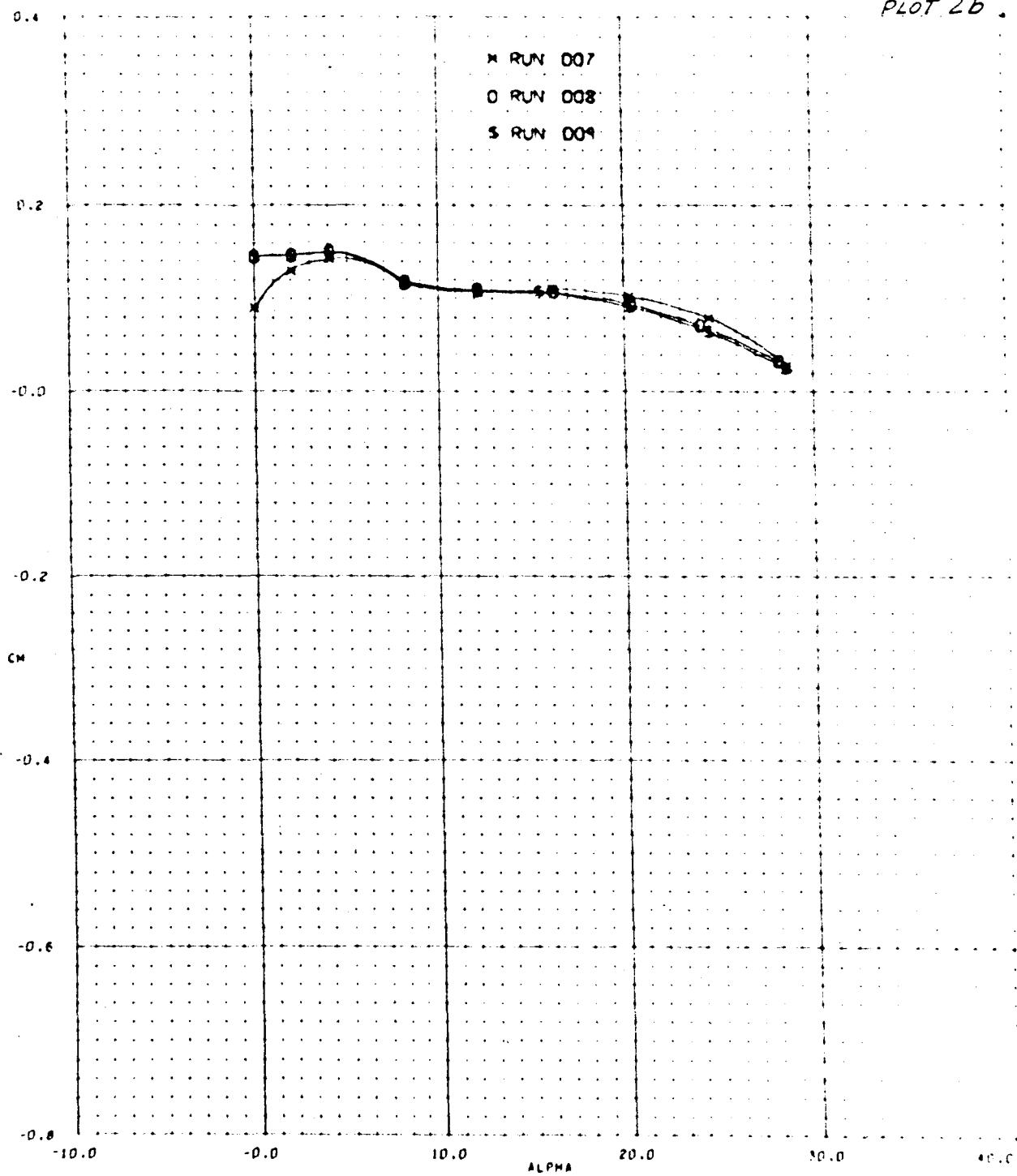
Fig. 2. Sign conventions

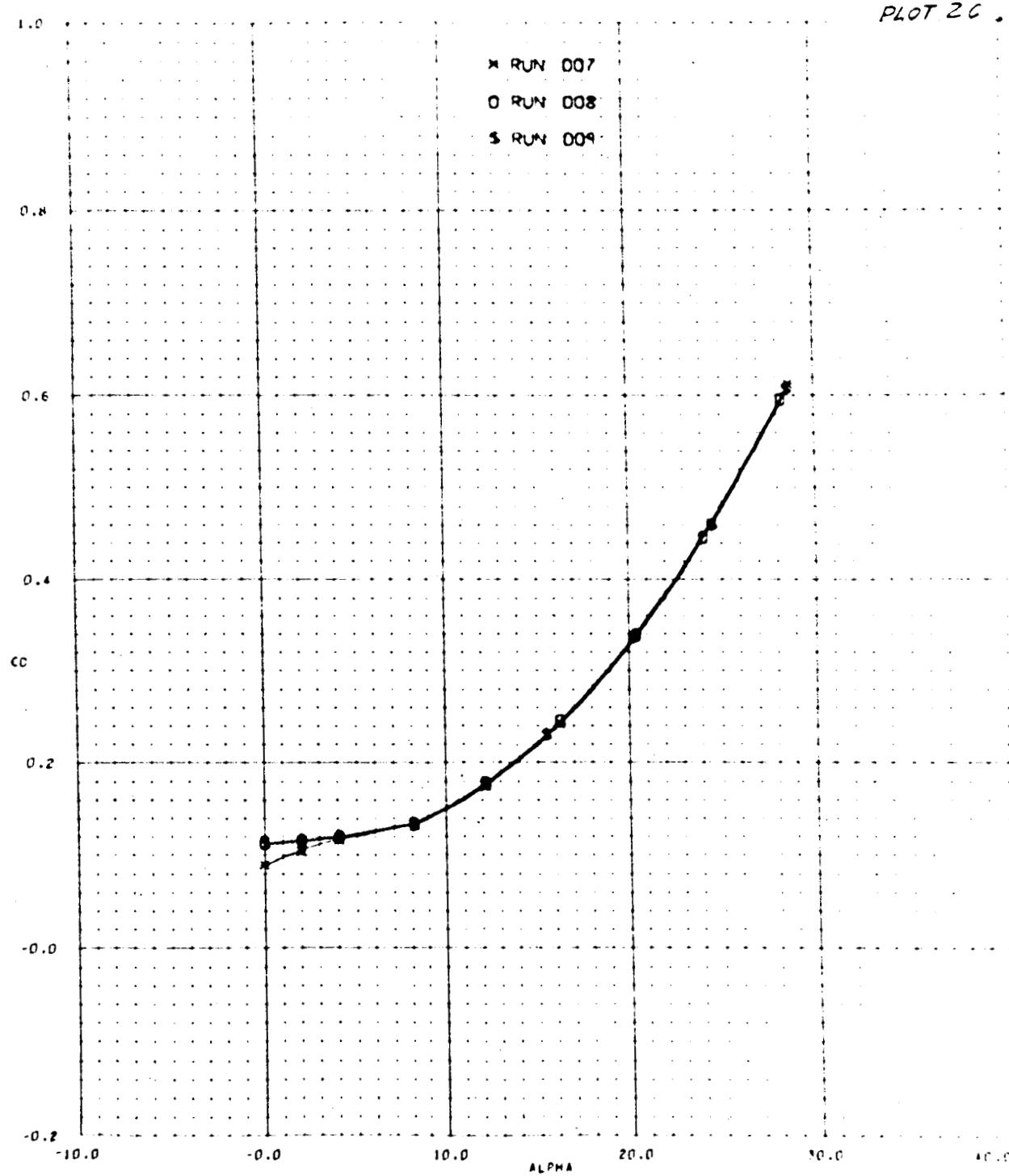


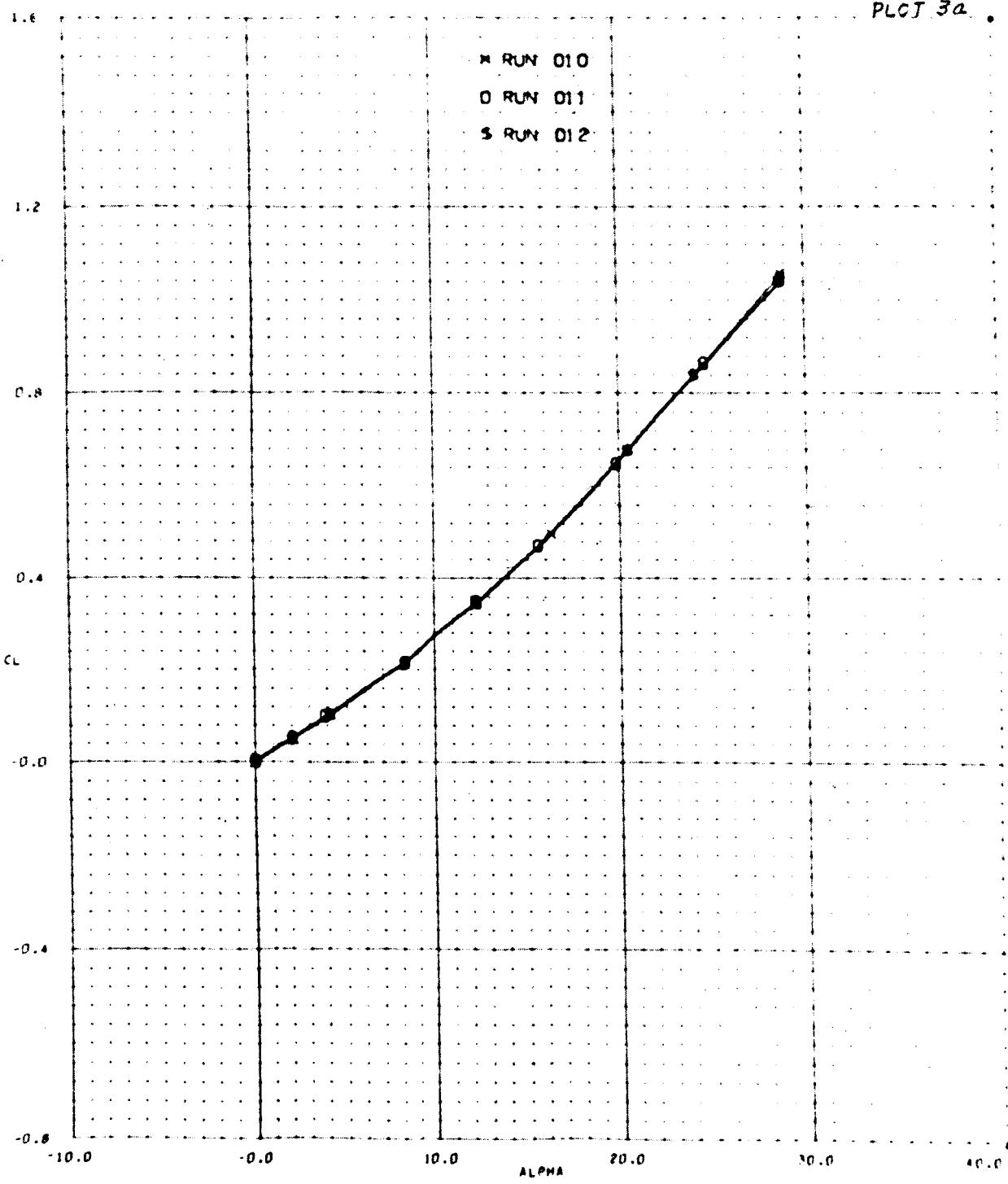




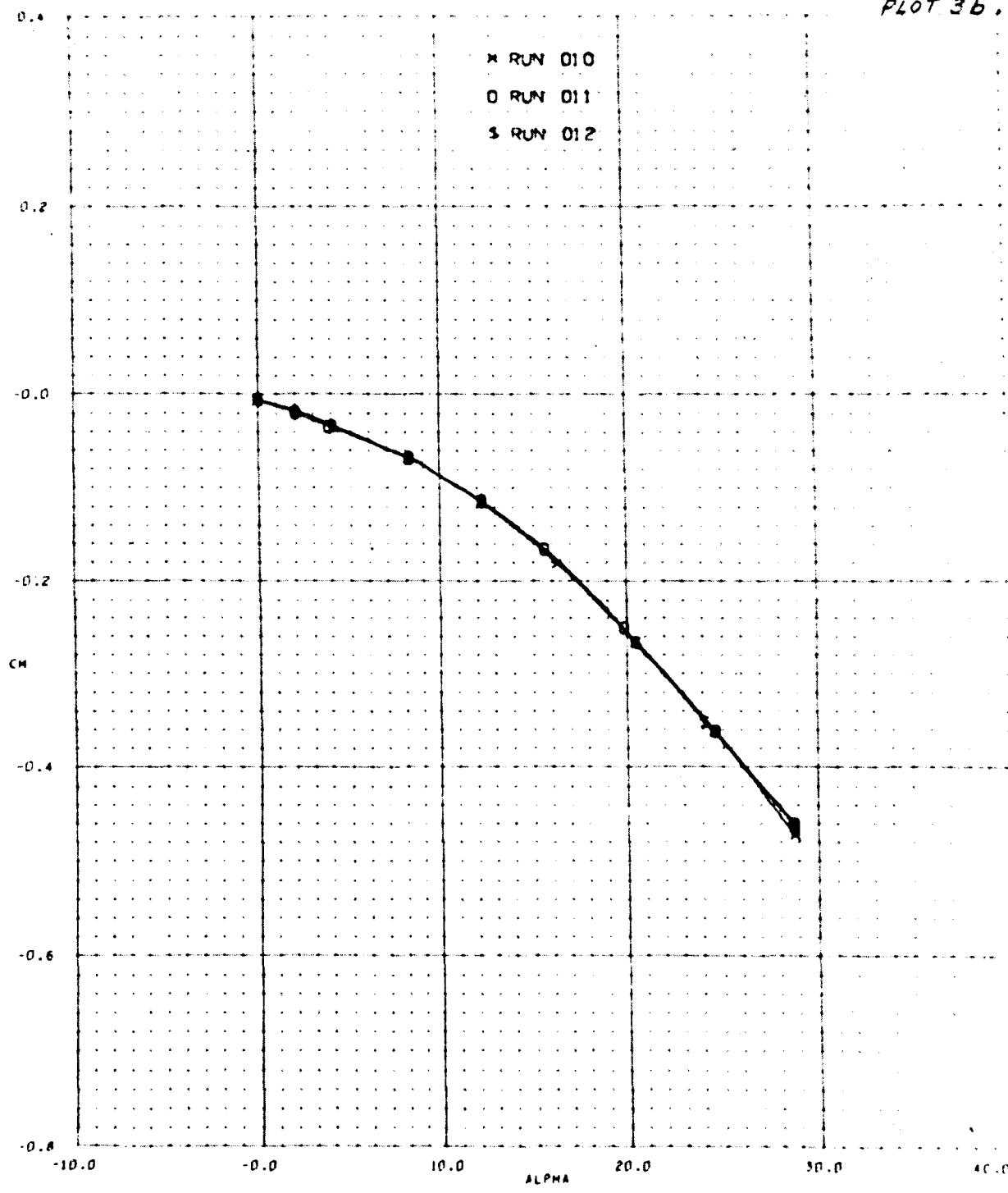


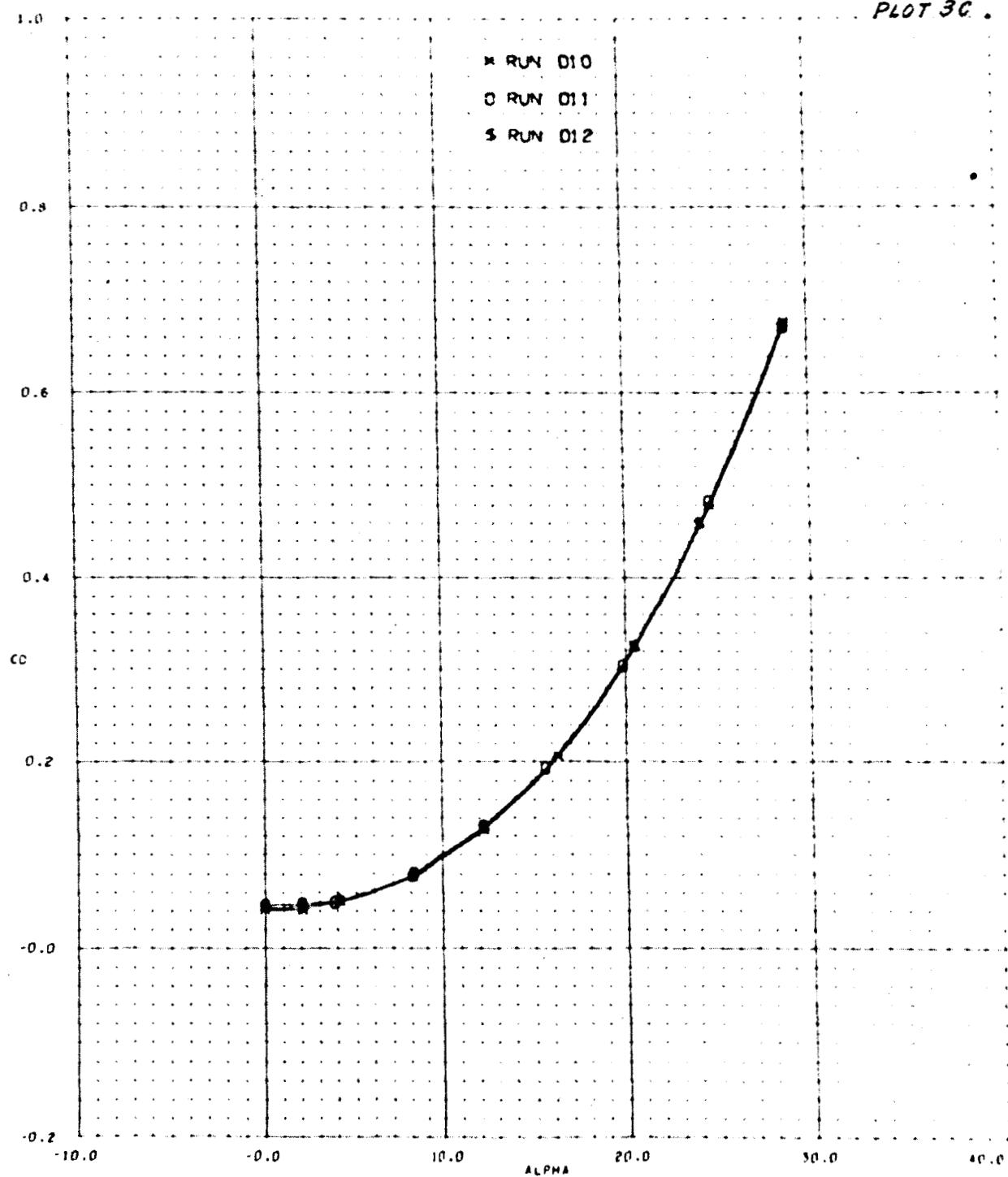


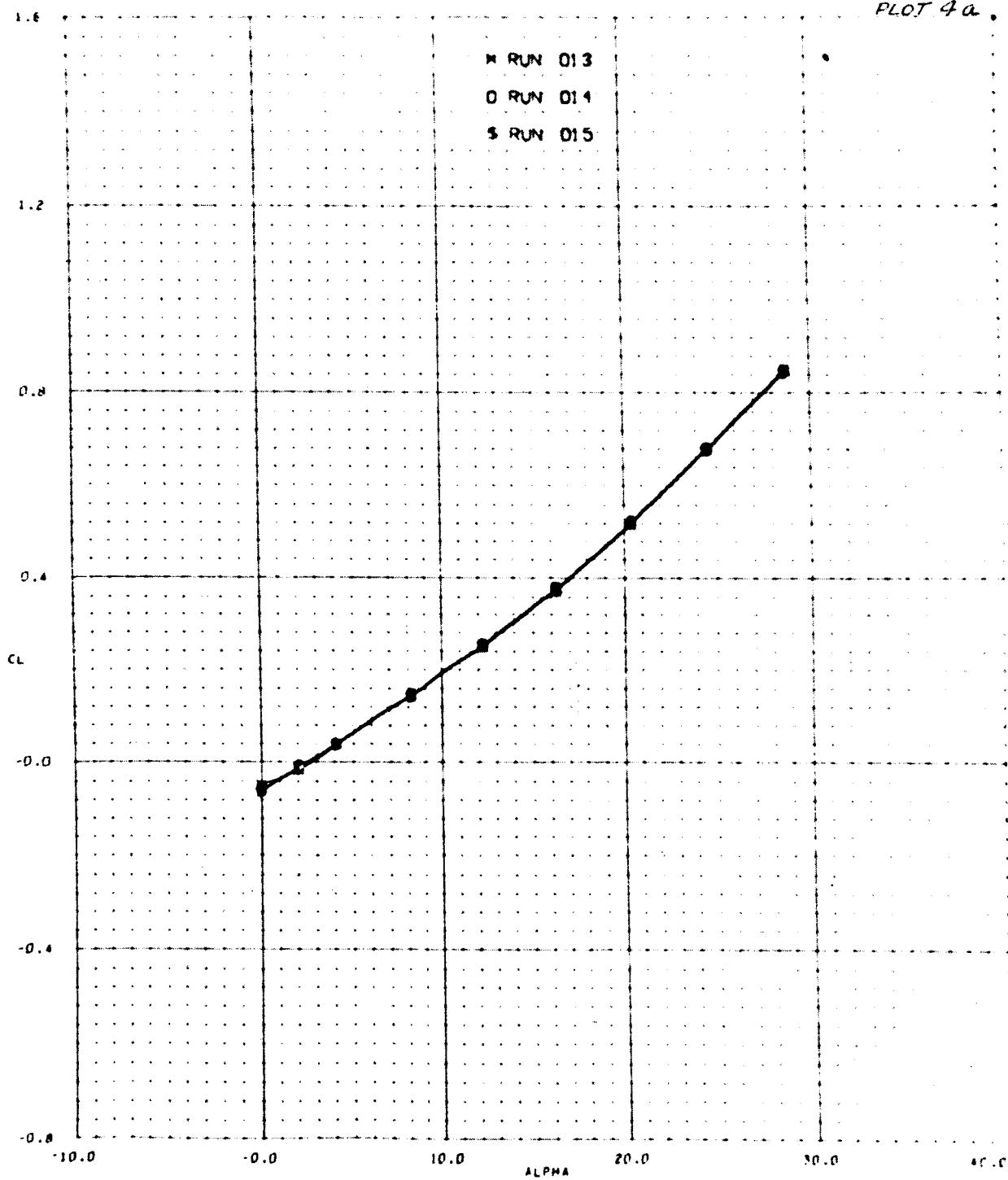




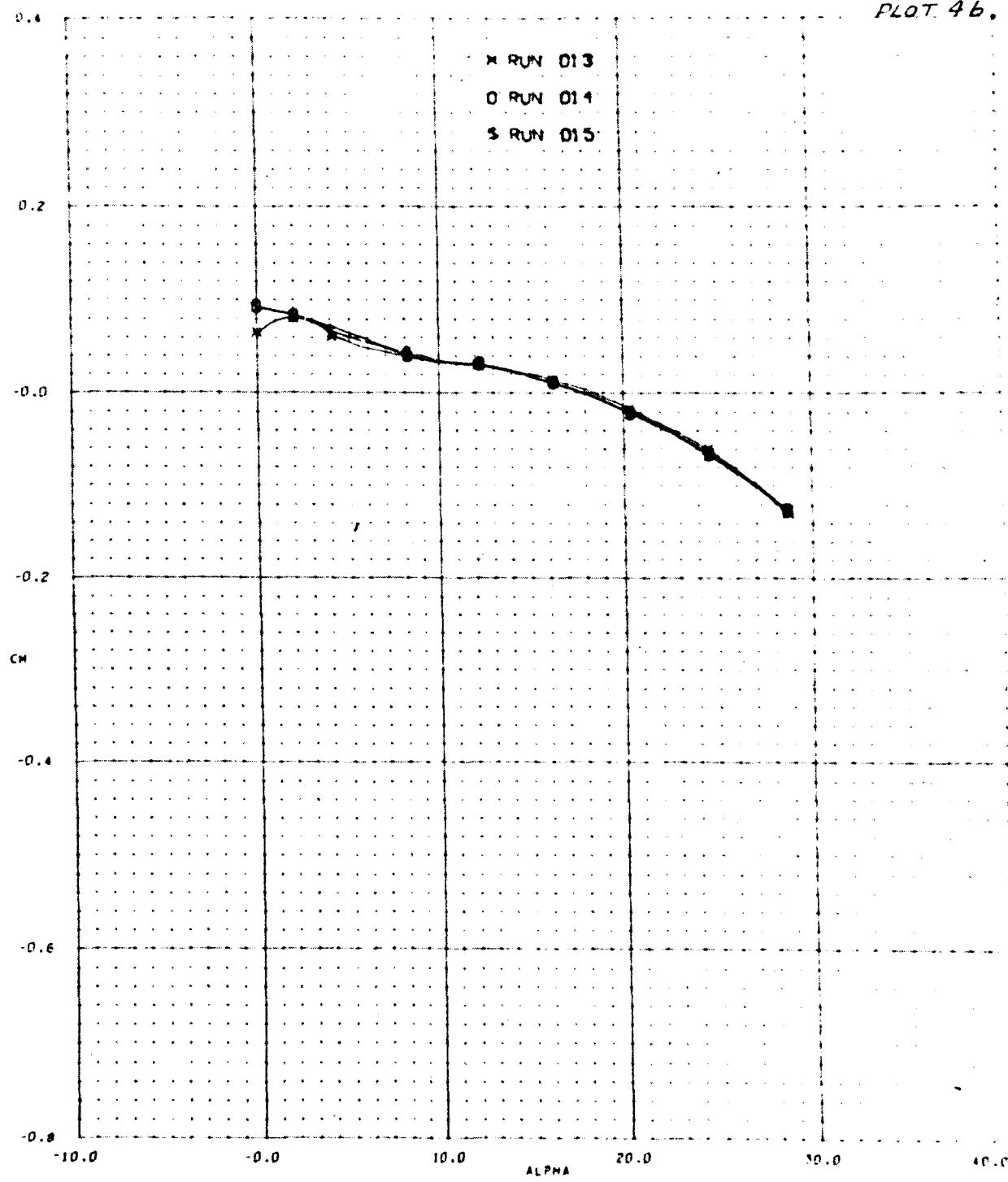
PLOT 36.

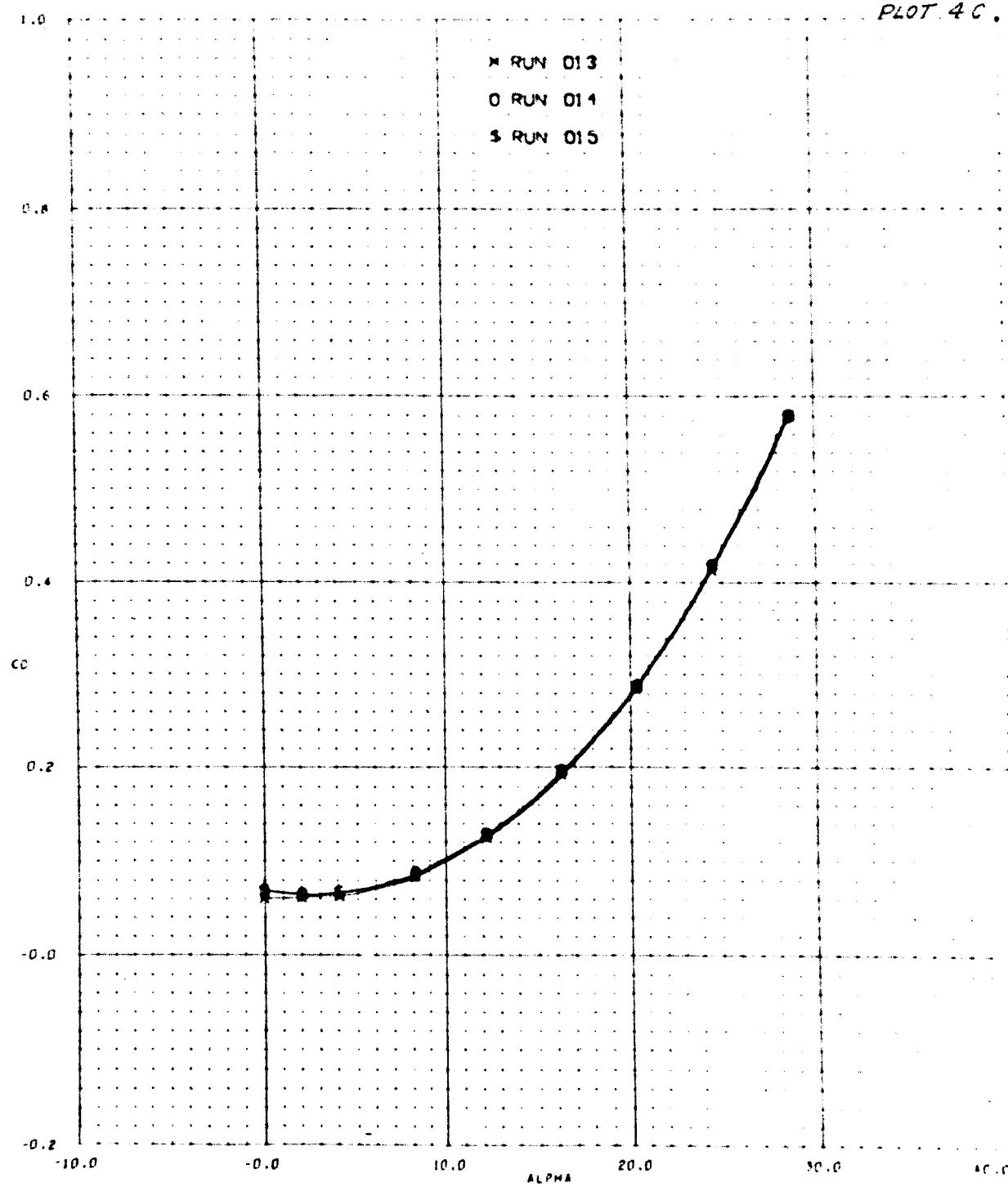


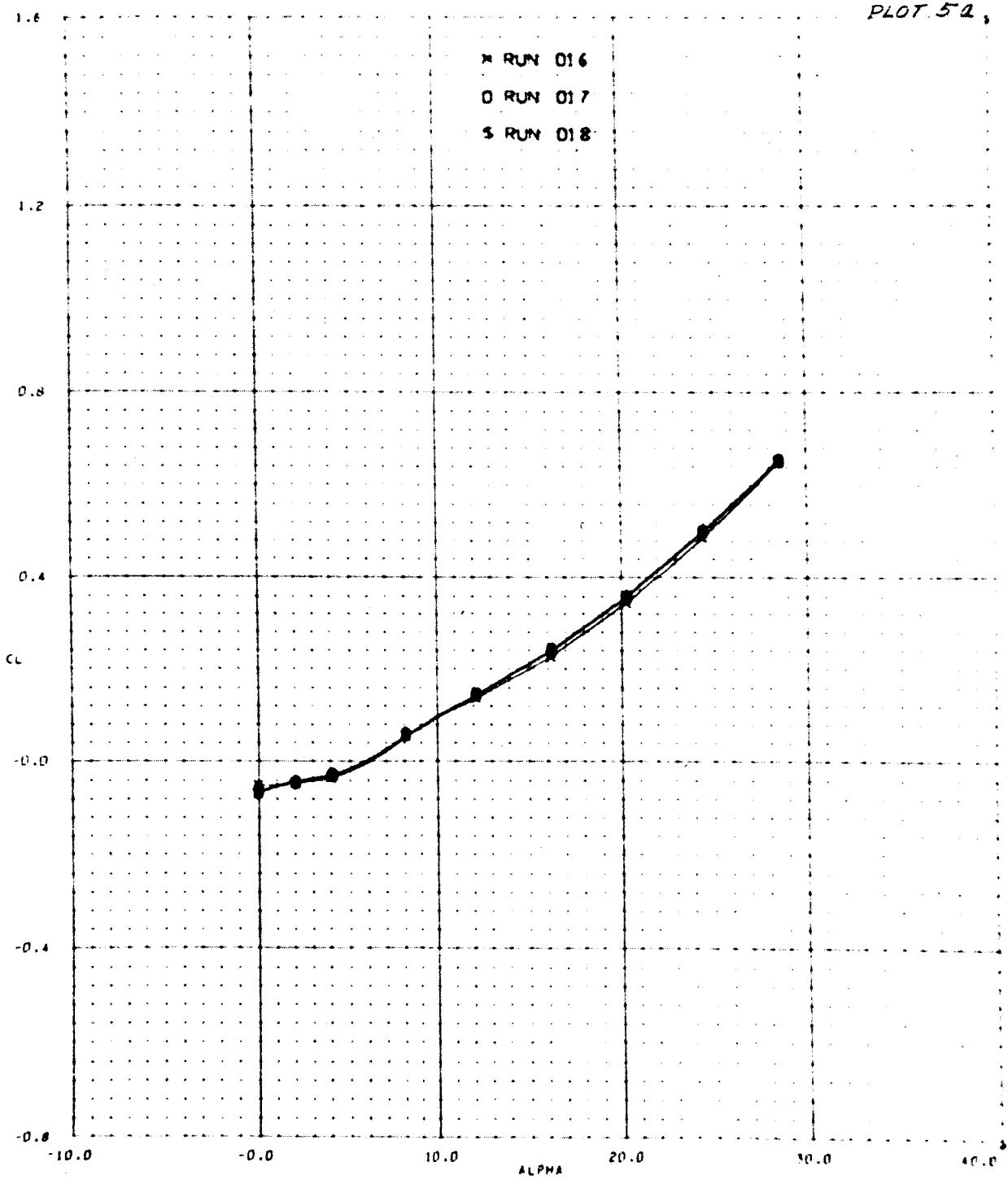




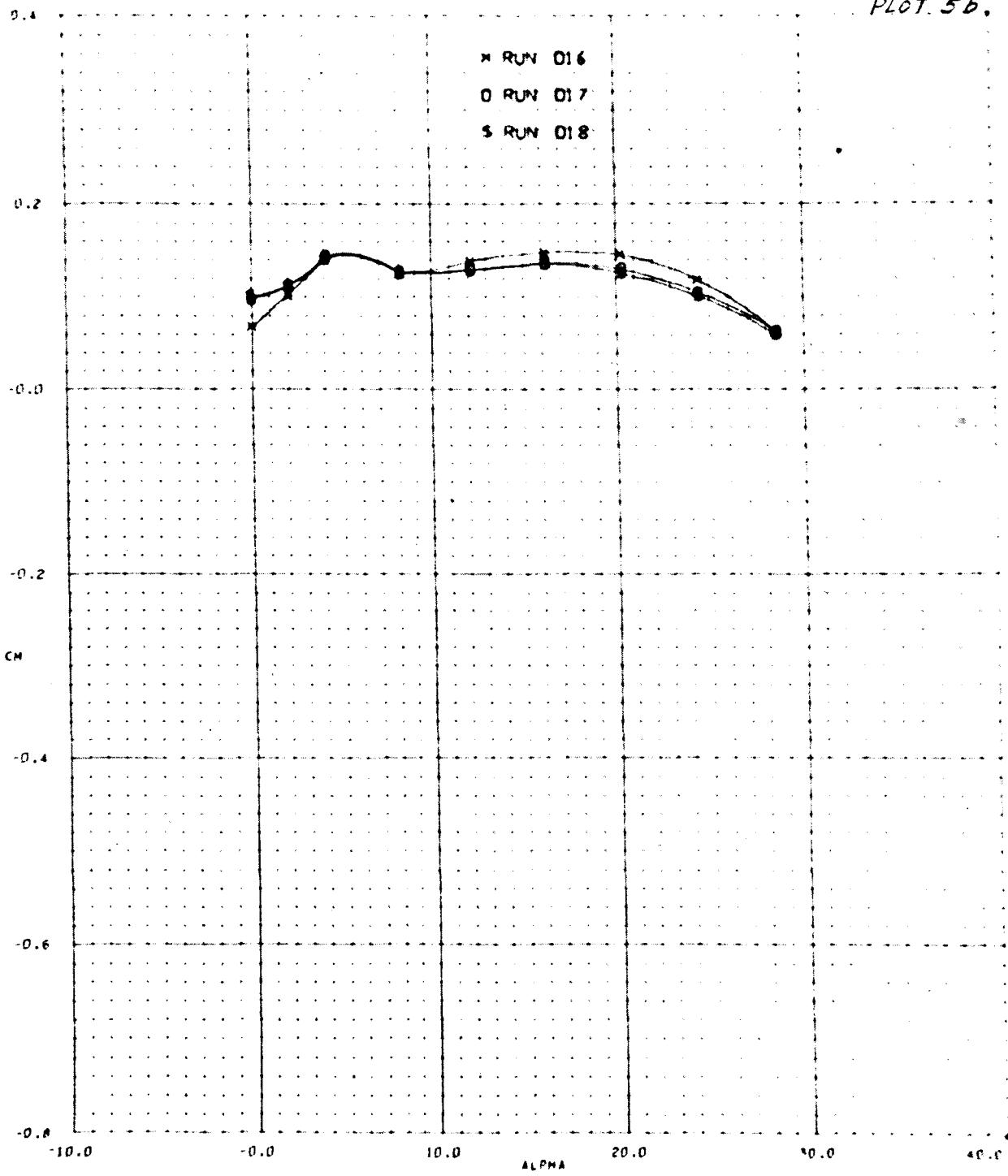
PLOT 4b.

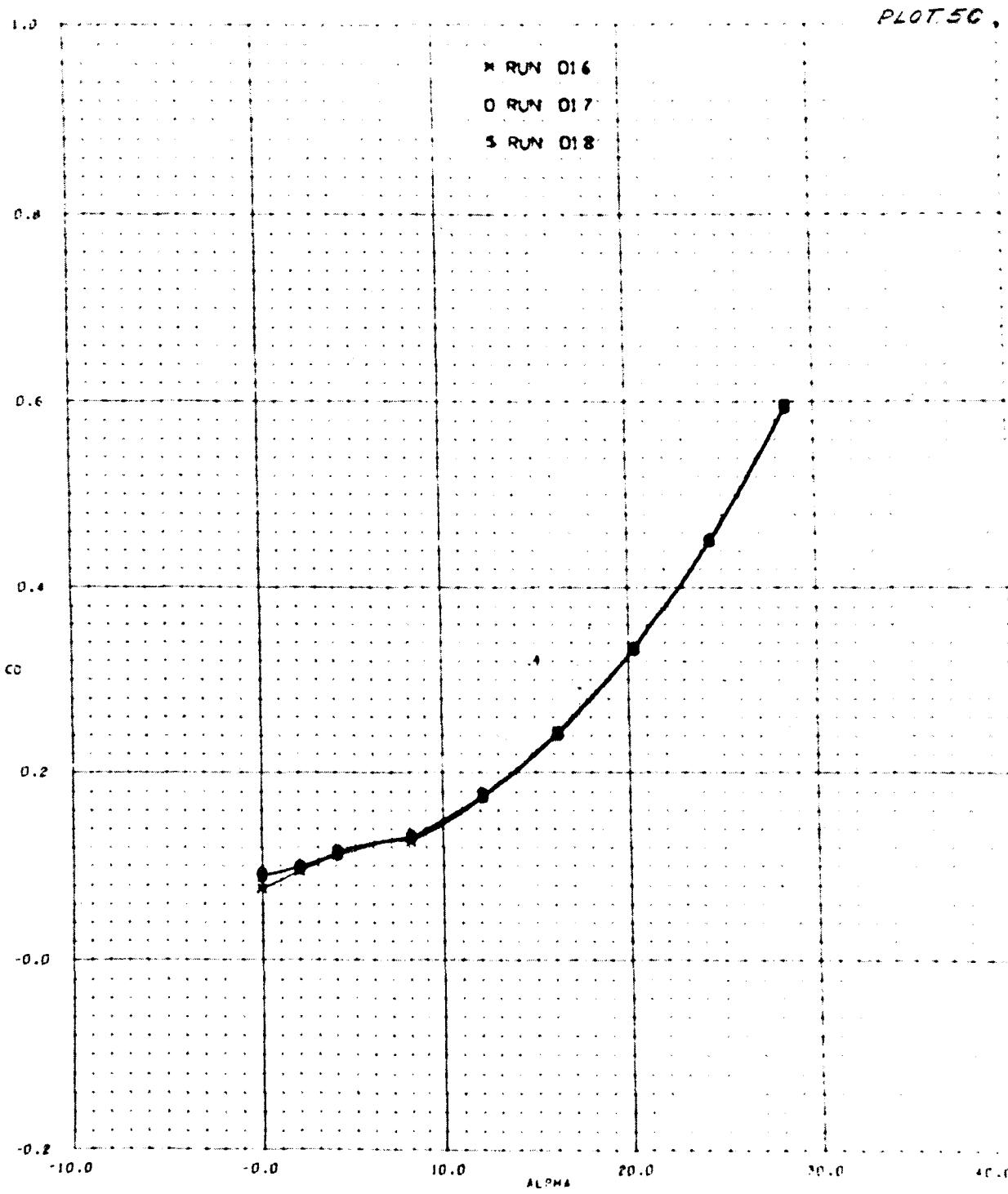




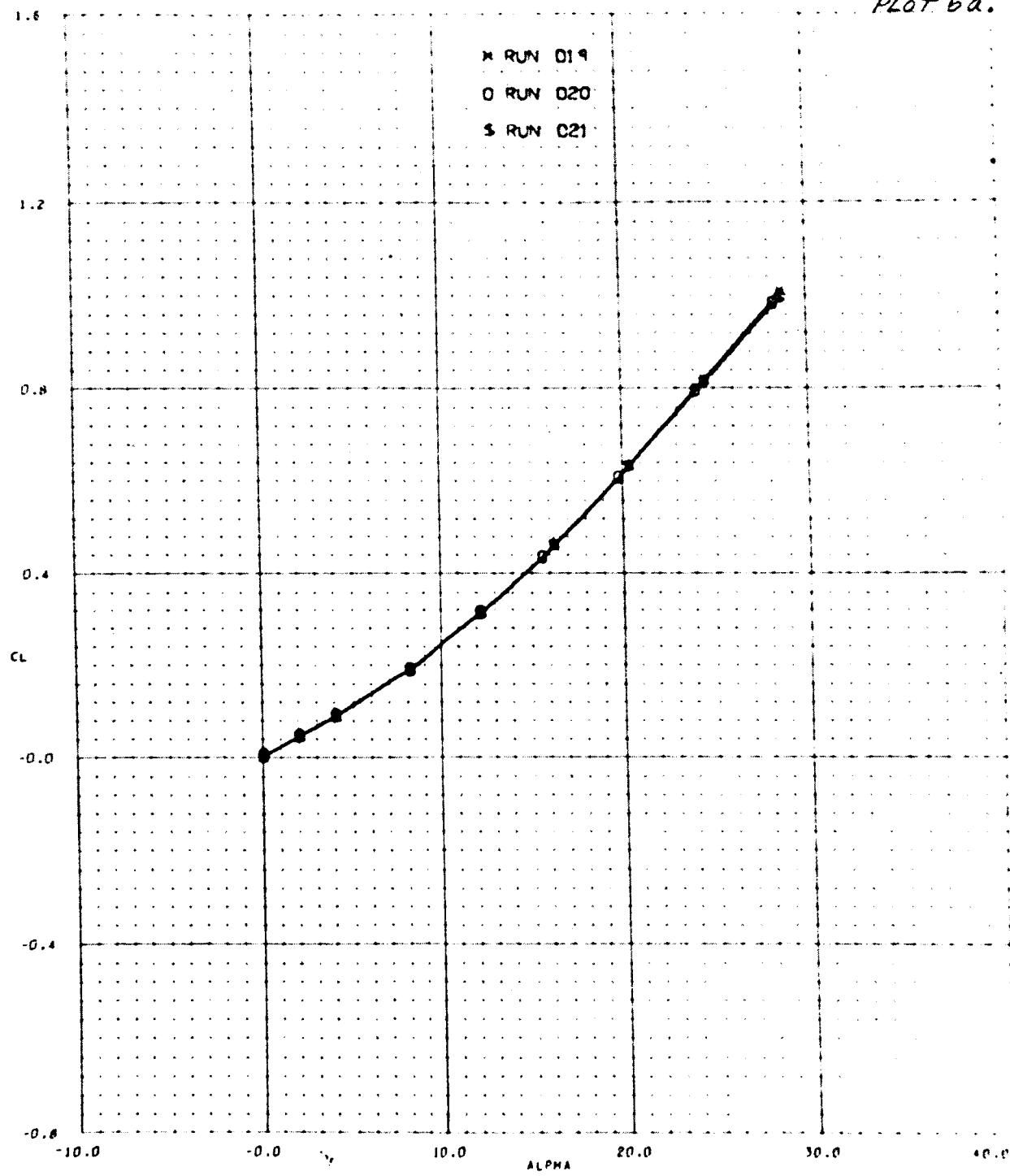


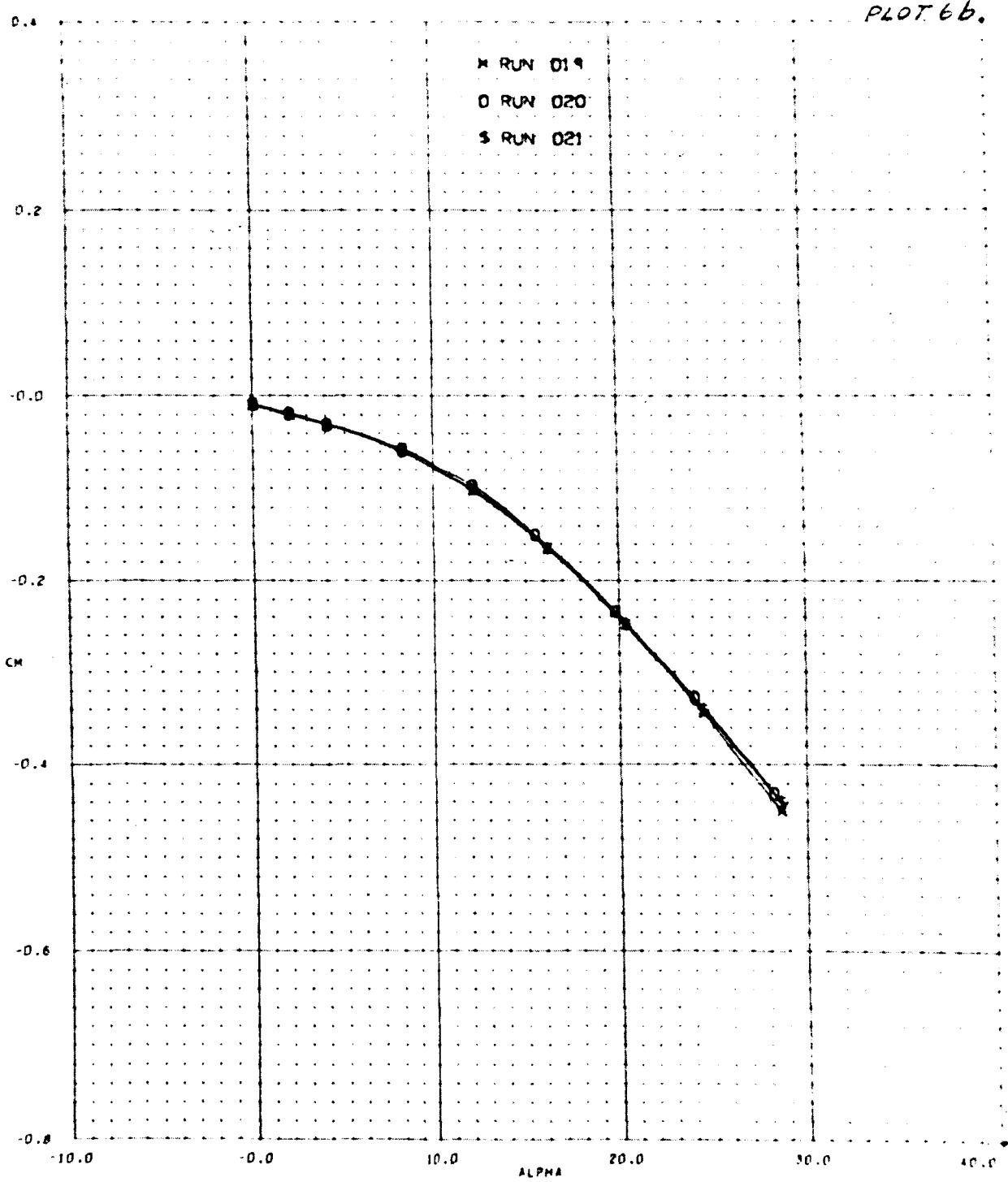
PLOT 5b.



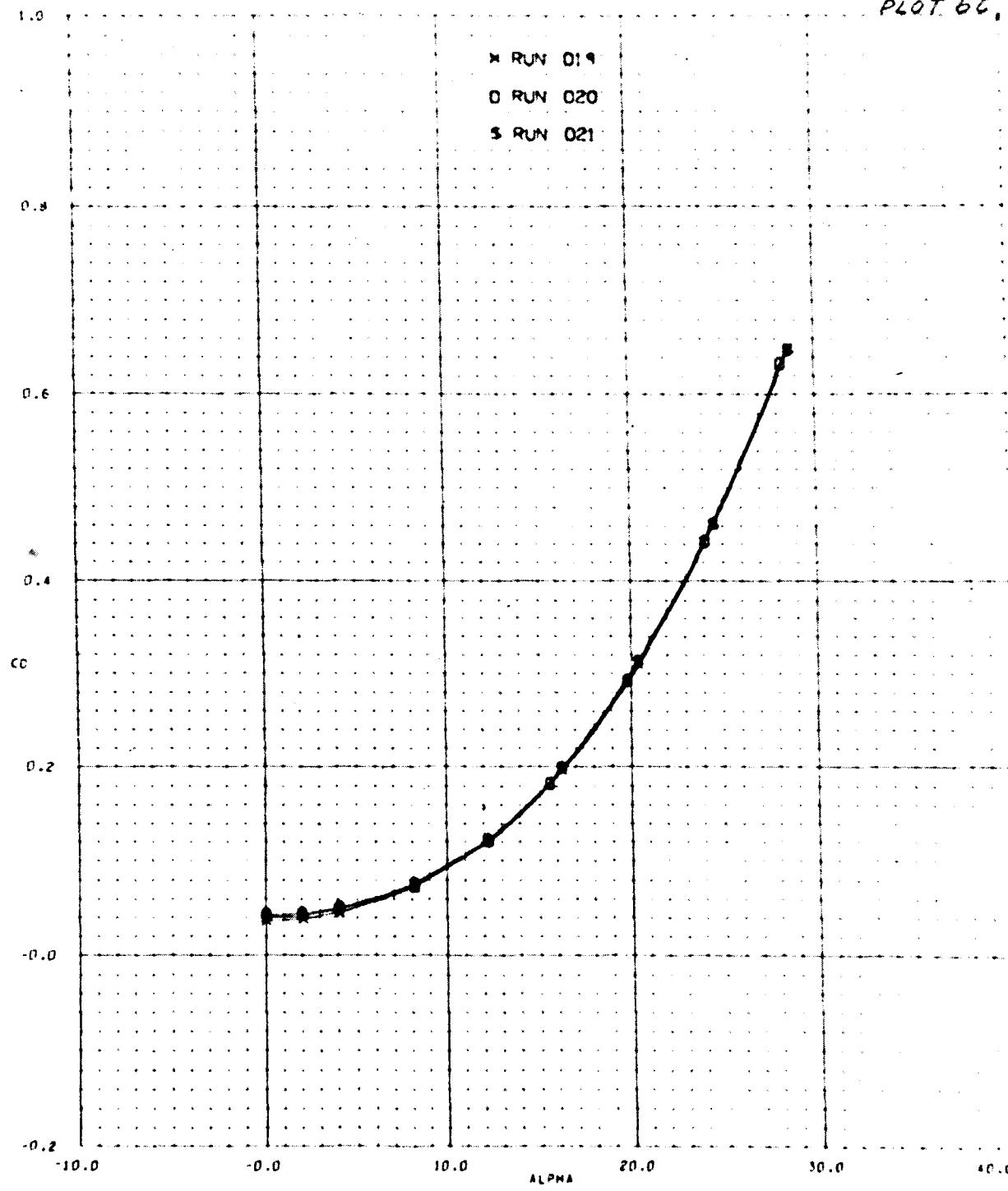


PLOT 6a.

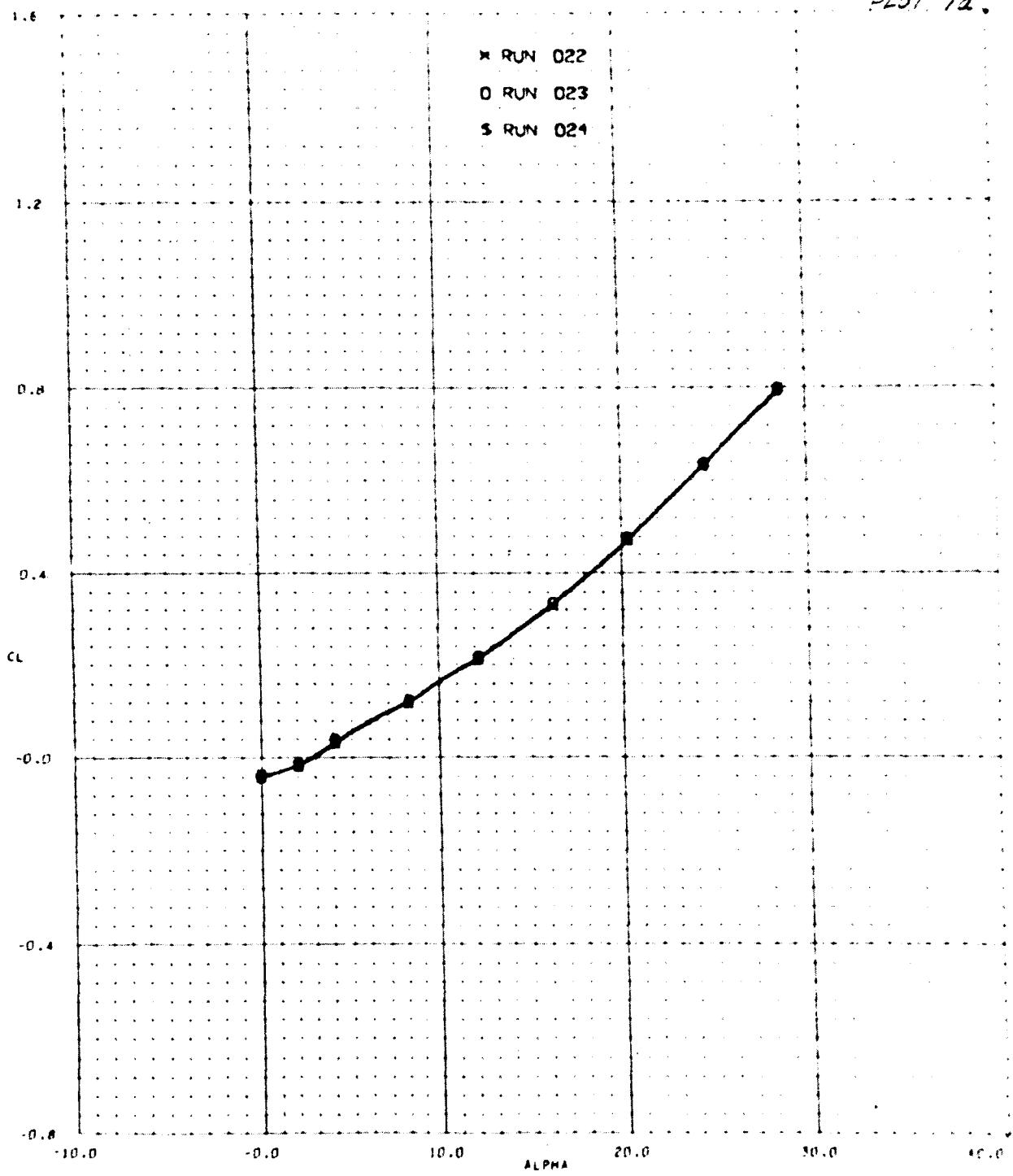




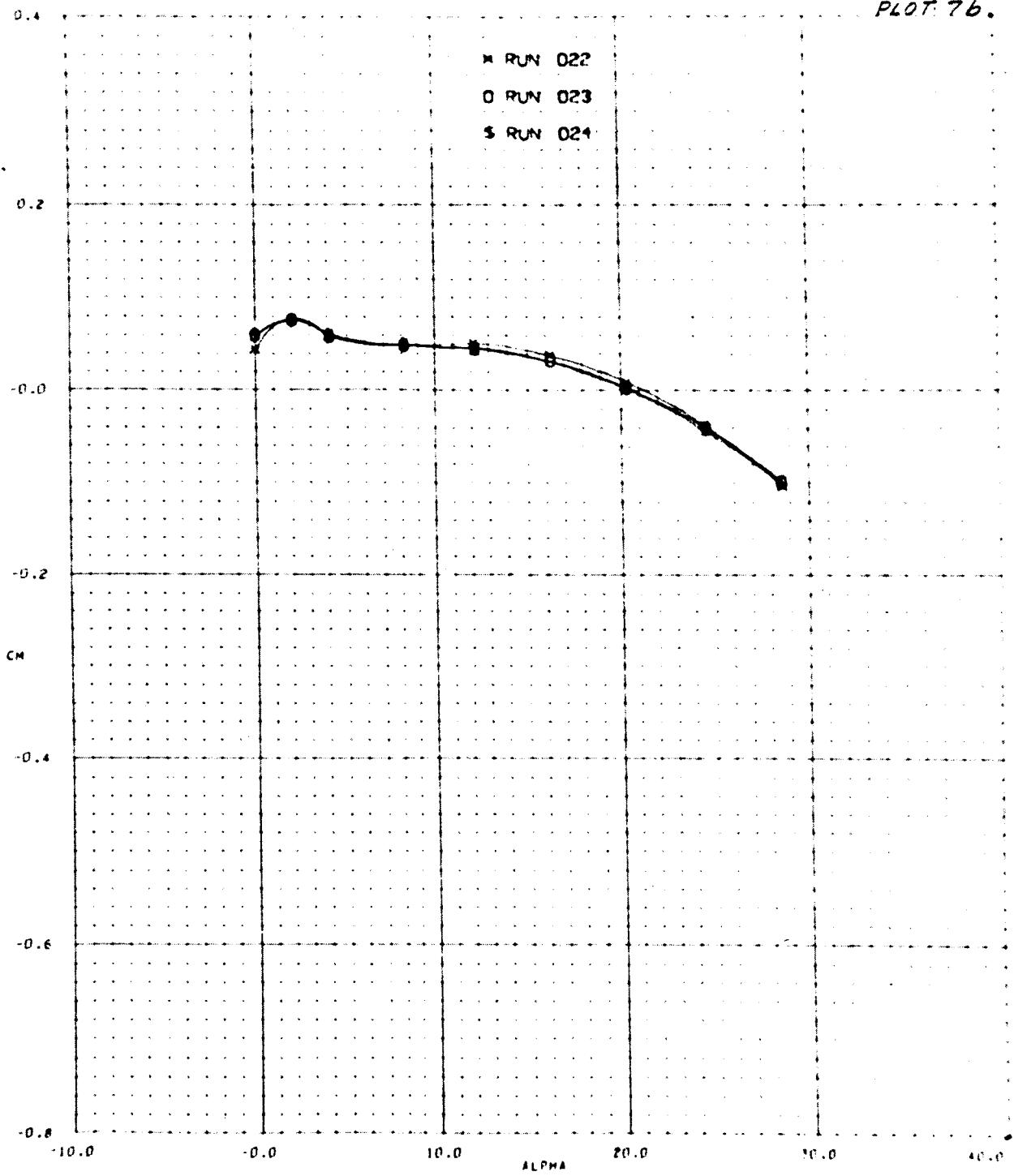
PLOT 66.

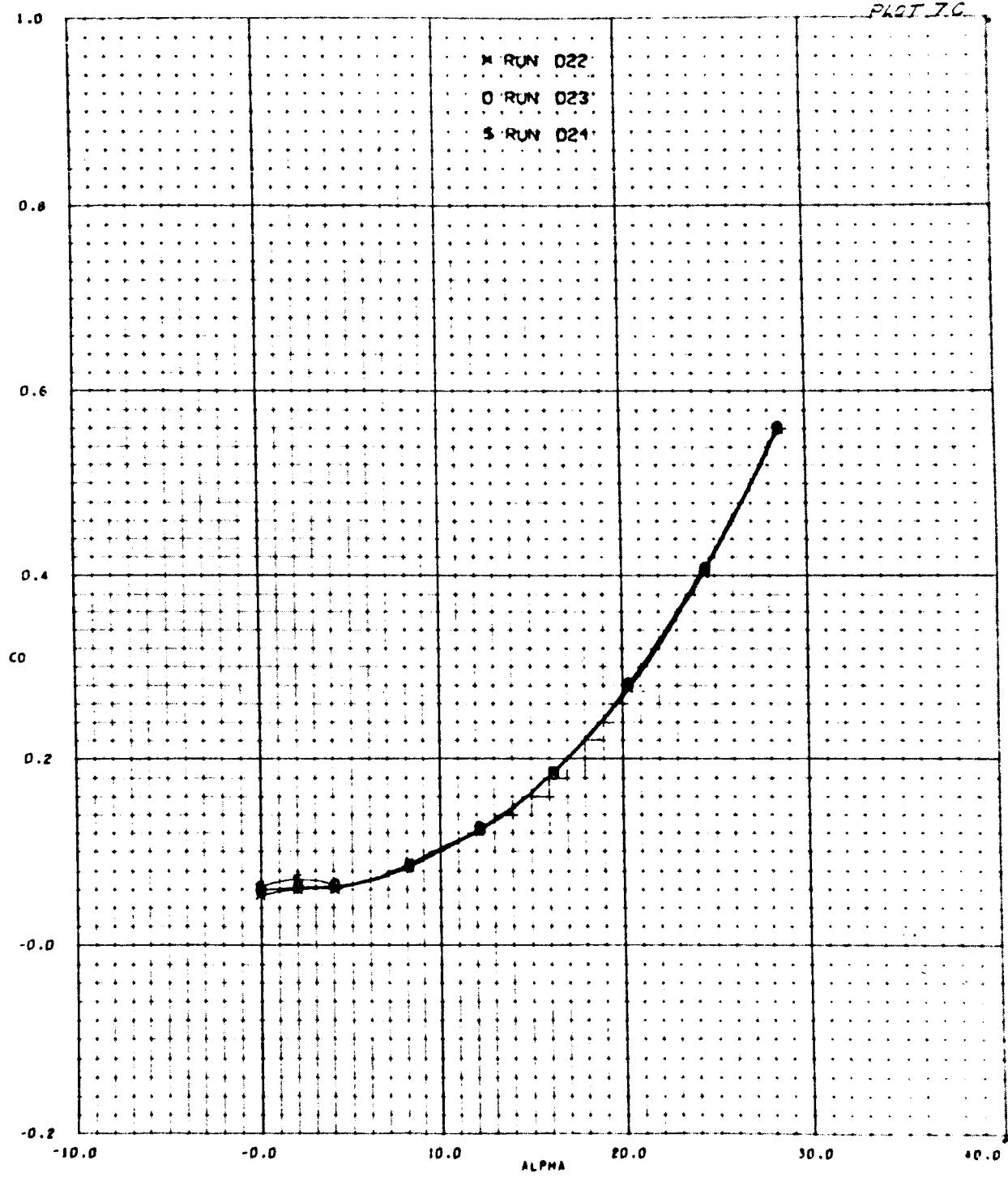


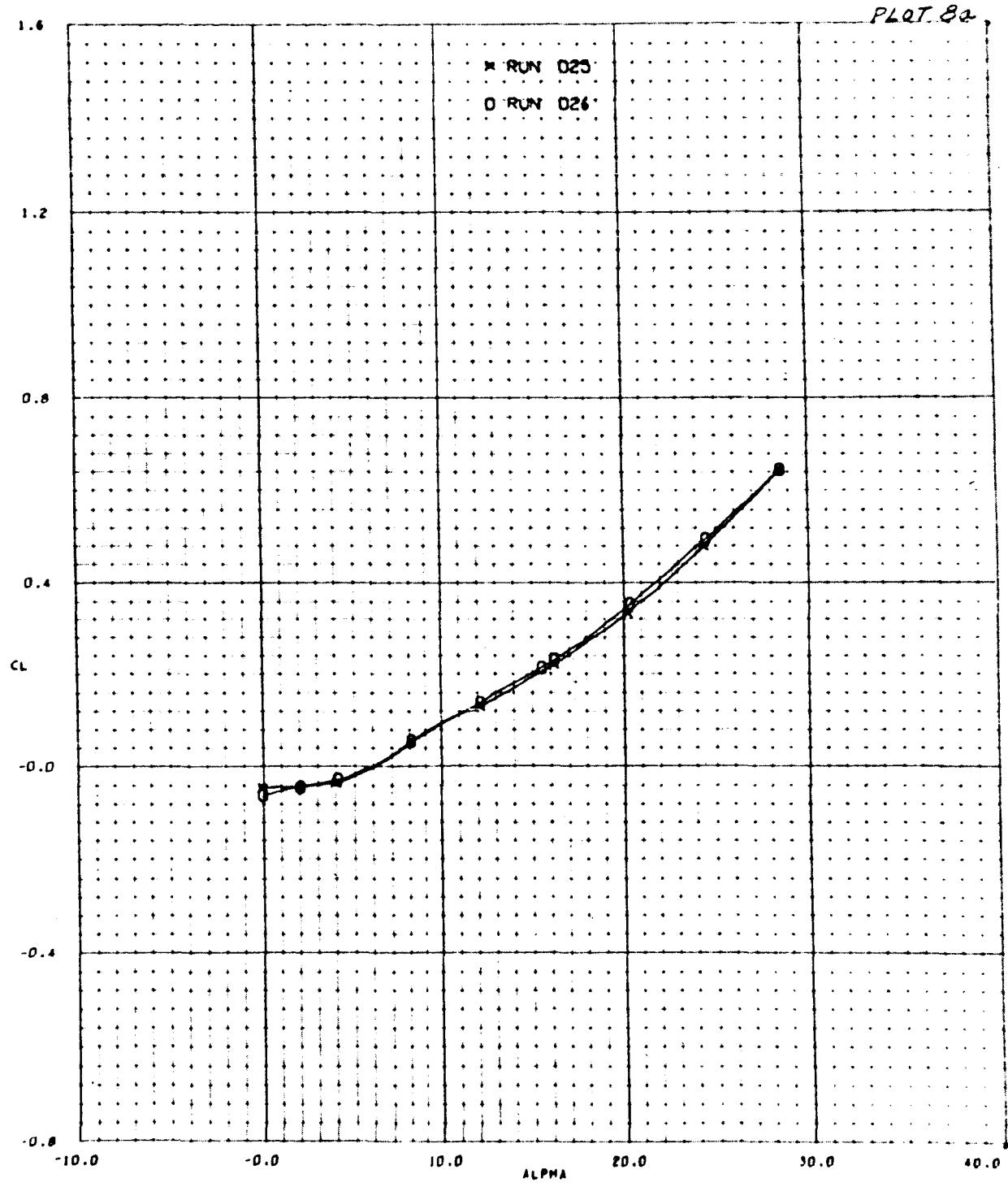
PLOT 72.

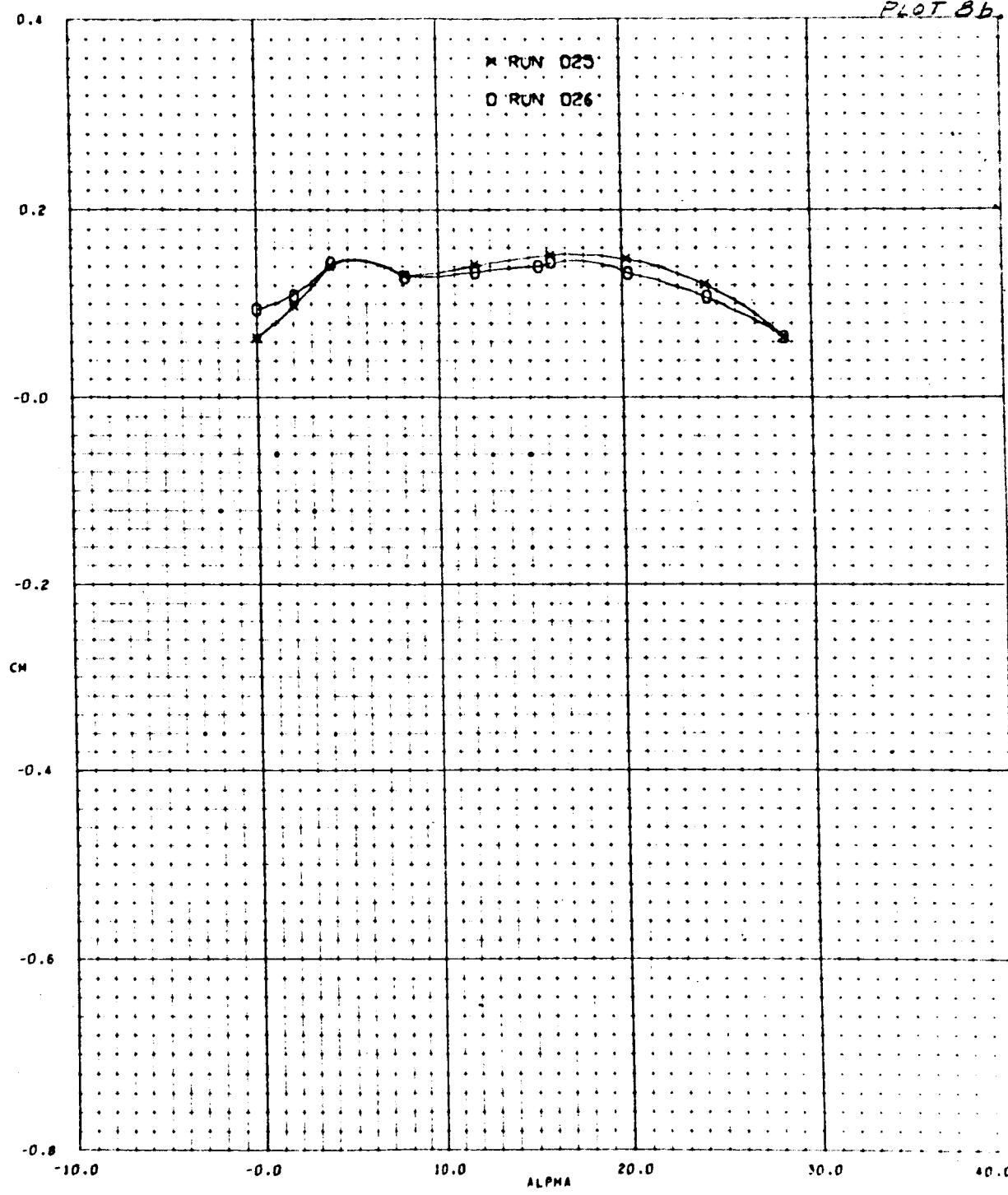


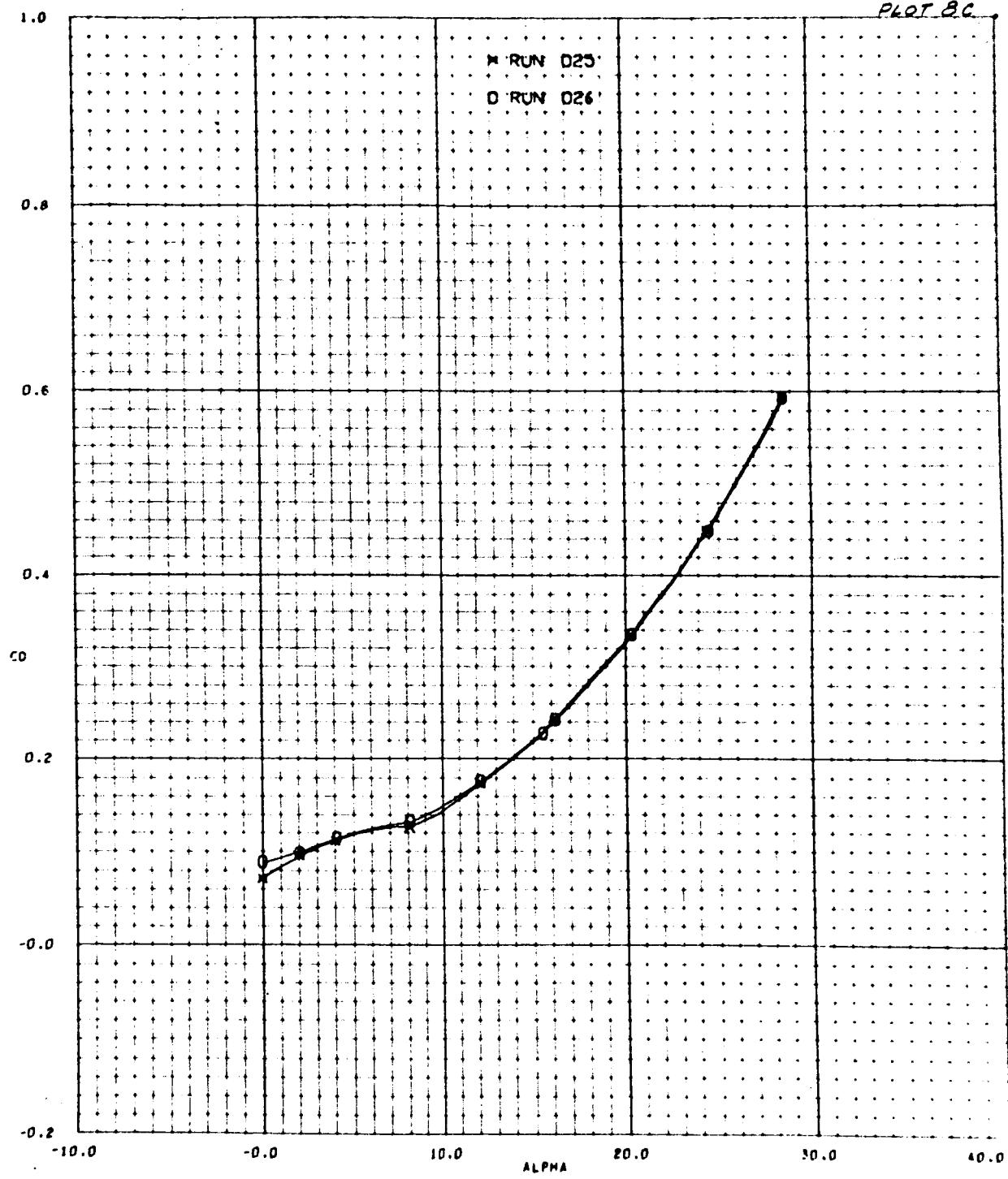
PLOT 76.

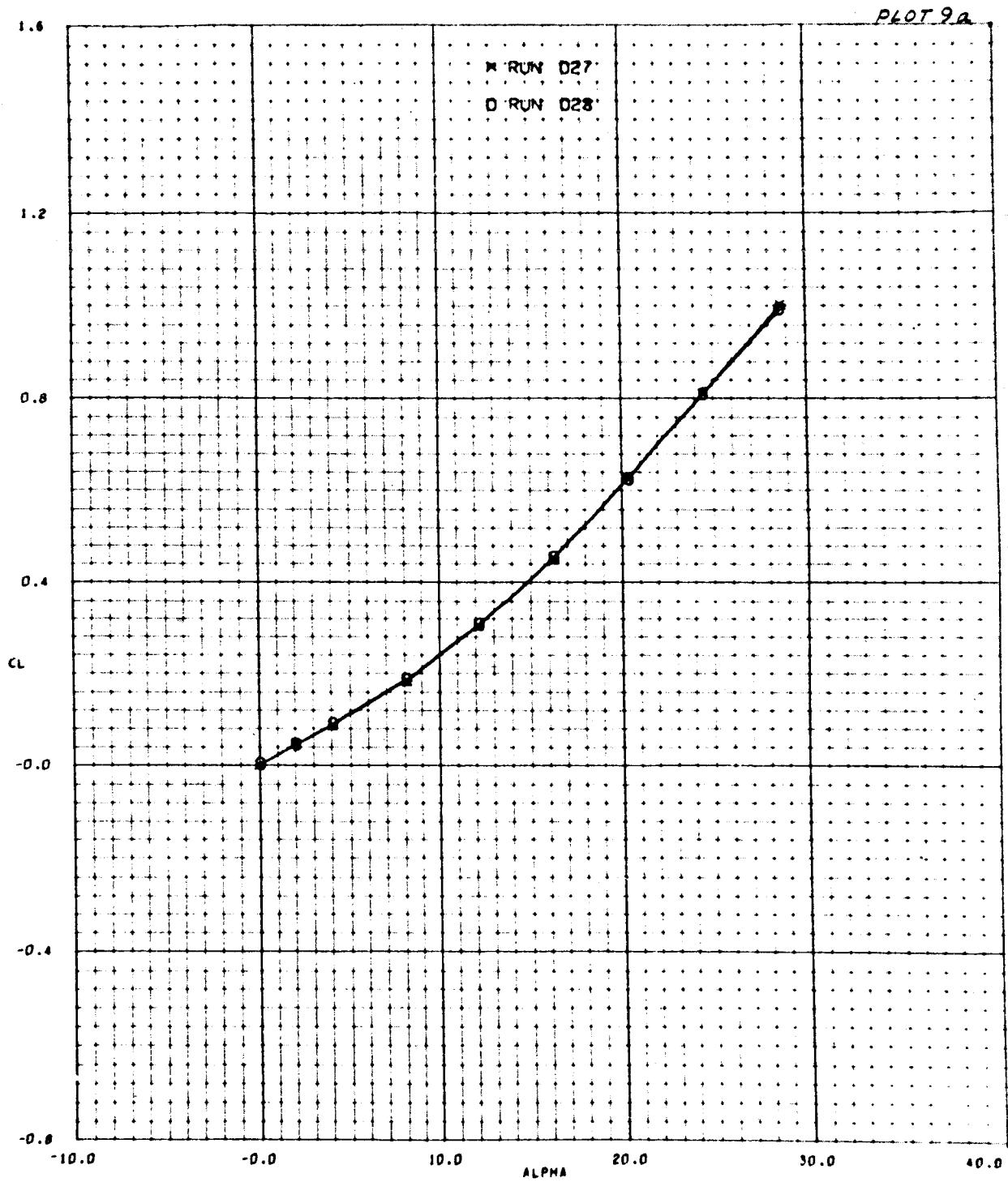




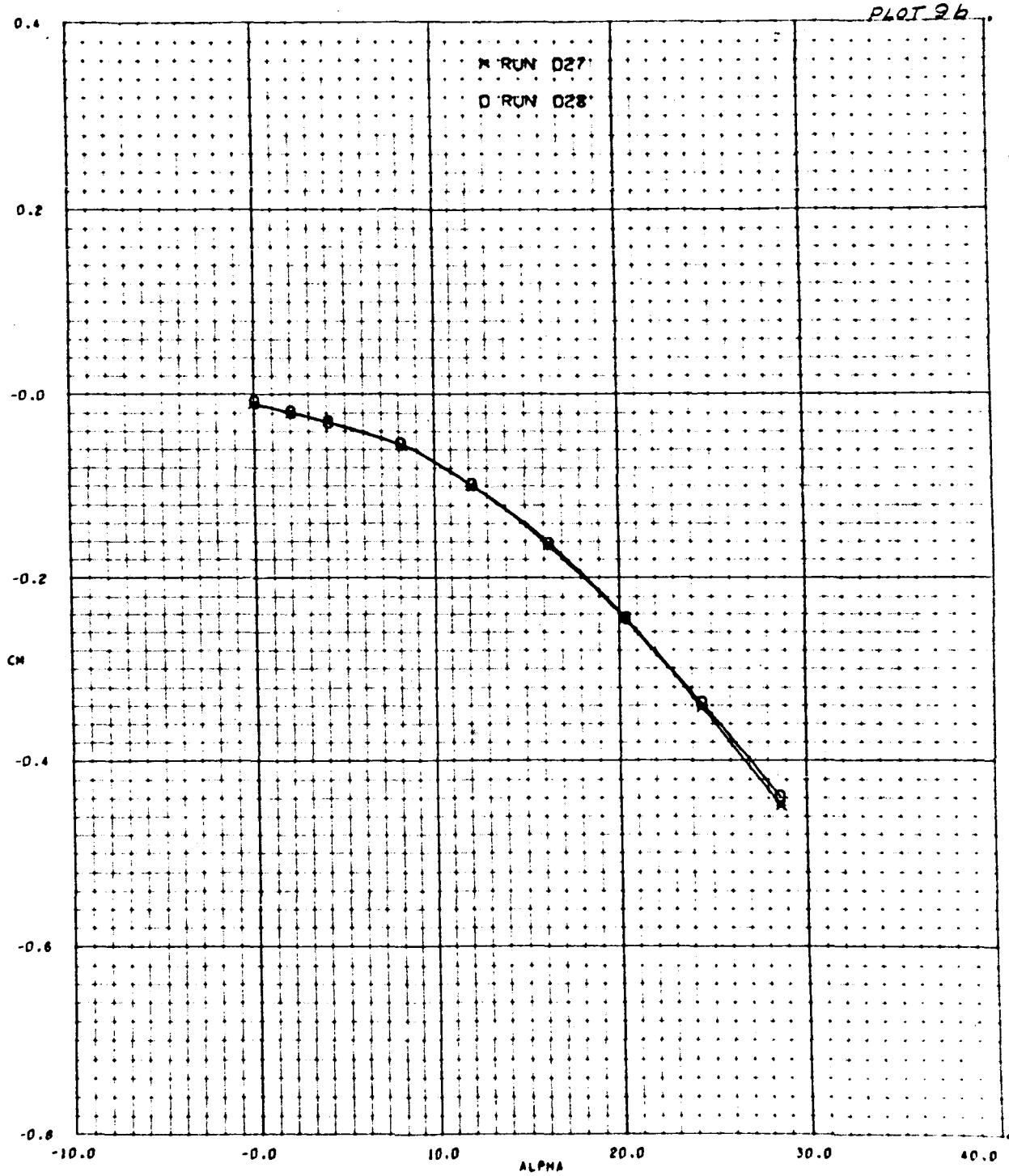


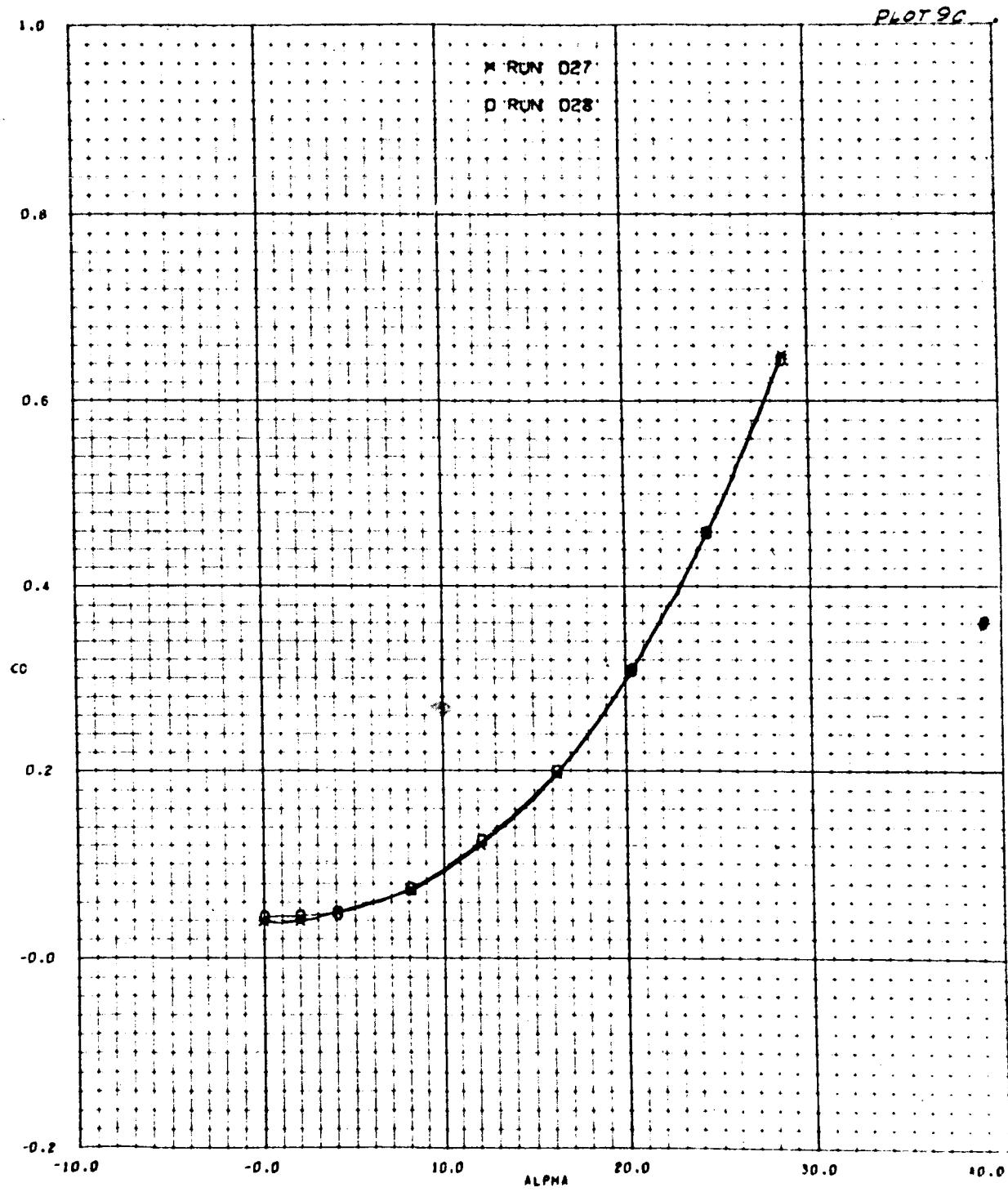


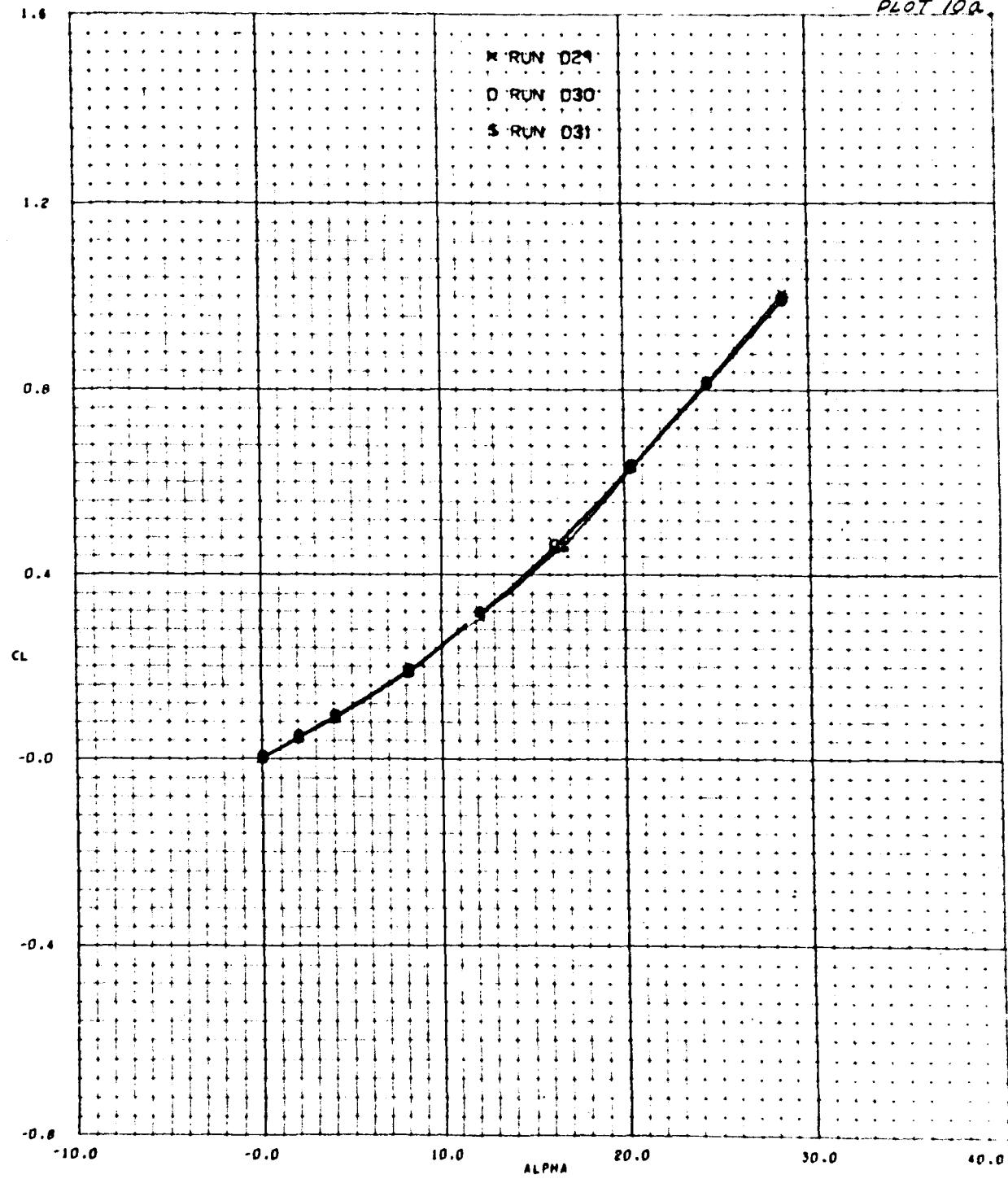




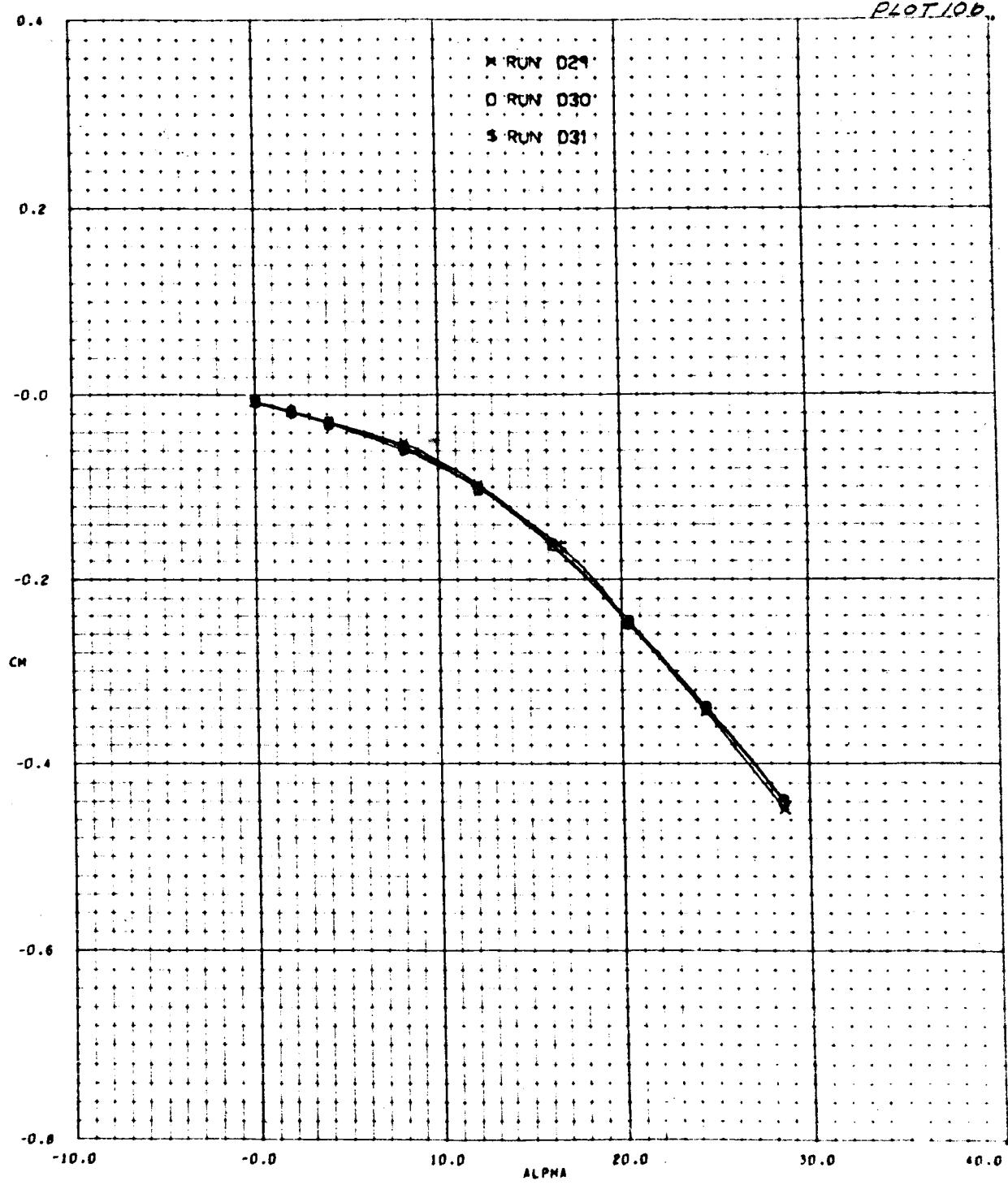
25



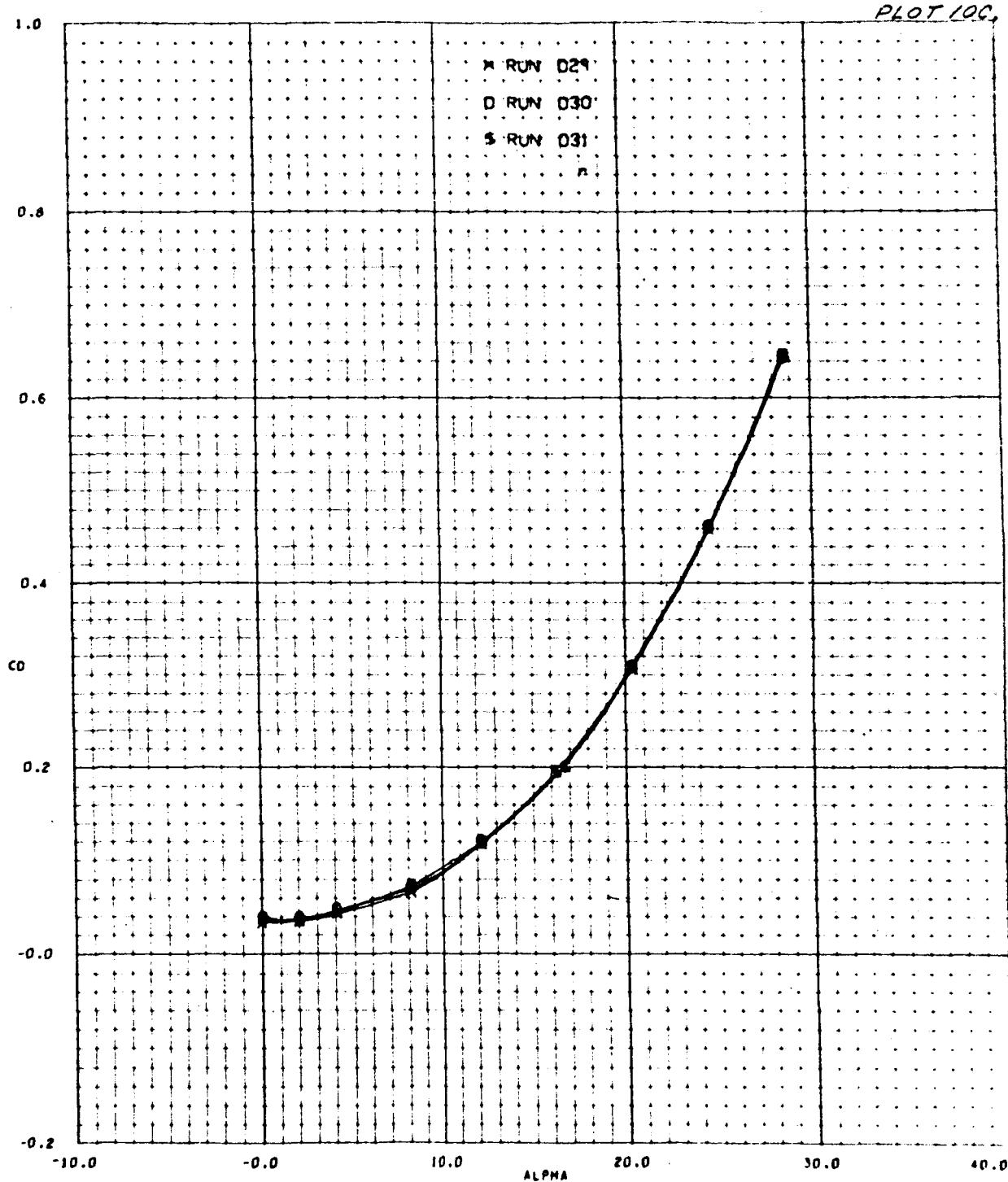




28



29



30